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THESIS

AN EXPERIMENTAL INVESTIGATION OF THE INTERACTION BETWEEN FEEDBACK AND GOALS ON STAFF RESOURCE ALLOCATION

by

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June, 1996

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The Department of Defense Information Technology budget stands at nine billion dollars and is under severe scrutiny while the backlog of required software continues to grow. It is thereby necessary to improve the efficiency of managing the software process. This thesis uses the Systems Dynamic Model of Software Project Management to investigate the effects of stated goals and project feedback on project manager behavior. Specifically, the experiment focuses on how software project managers allocate resources in both factual and erroneous feedback environments. The effect of goals and feedback on manager performance are measured in terms of staffing level decisions, percent of staff allocated to quality assurance activities, estimated schedule; estimated programmer productivity, and estimated cost. The results show that manager performance is highly sensitive to stated goals.

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AN EXPERIMENTAL INVESTIGATION OF THE INTERACTION BETWEEN FEEDBACK AND GOALS ON STAFF RESOURCE ALLOCATION

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ABSTRACT

The Department of Defense Information Technology budget stands at nine billion dollars and is under severe scrutiny while the backlog of required software continues to grow. It is thereby necessary to improve the efficiency of managing the software process. This thesis uses the Systems Dynamic Model of Software Project Management to investigate the effects of stated goals and project feedback on project manager behavior. Specifically, the experiment focuses on how software project managers allocate resources in both factual and erroneous feedback environments. The effect of goals and feedback on manager performance are measured in terms of staffing level decisions, percent of staff allocated to quality assurance activities, estimated schedule, estimated programmer productivity, and estimated cost. The results show that manager performance is highly sensitive to stated goals.

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I. INTRODUCTION

A. BACKGROUND

Department of Defense (DOD) software development costs have outstripped hardware costs and are continuing to grow. The major factors contributing to this growth of software costs are the continuing increase in the size and complexity of software systems and an international climate that calls for rapid adaptation to new situations. While at the same time, DOD and the Congress have stressed the importance of reducing the cost, time, and effort required to build and maintain software systems. Currently, the DOD Information Technology budget stands at nine billion and is under severe scrutiny while the backlog of required software continues to grow. It is thereby necessary to improve the efficiency of managing the software process.

Prior research suggests that programmers are goal driven. In a 1974 paper, (Weinberg and Schulman, 1974) showed that programming team performance is highly sensitive to given objectives. The paper showed that each team finished best with respect to the objective they were asked to optimize. Further research suggests that software managers are also highly sensitive to stated goals. In a 1995 paper, (Swett, 1995) demonstrated using graduate students in an Information Technology Management curriculum that software managers are highly sensitive to goals and perform best in the goals they are given. Two important conclusions have been drawn from this research. First, that managers/programmers have very high achievement motivation toward their goals. Second, that different software goals are in conflict with each other.

Recently, the interaction between goals and feedback have been the subject of scrutiny by several researchers. Information about ones performance (feedback) has been hypothesized to enter into the goal-setting process by serving to evaluate assigned goals to both determine goal acceptance and to form personal goals. A study using graduate students focused on feedback as a necessary condition for goals to effect performance. It was predicted that feedback and goals would interactively relate to performance. Results supported the hypothesis by indicating that the individual differences in the self-set goals were

significantly higher in the feedback group than in the no-feedback group, and that it was in the feedback condition that the relationship between goals and performance was significantly higher than in the no-feedback condition. Ref. 10

Research seems to suggest that feedback is a necessary condition for goals to effect performance, and although there has been past research on the effects of goals on the software management process, there has never been a past experiment focused on the interaction between feedback and goals to evaluate the performance of the software management process.

B. PURPOSE OF RESEARCH

The purpose of this thesis is to design, develop, and conduct an experiment using the System Dynamics Model (SDM) of Software Project Management developed in Ref. 2 to investigate whether managerial goals (i.e. schedule, cost, and quality) and project feedback will have a significant influence on managerial behavior and project outcome. Specifically, this research will investigate the impact of different schedule, cost, and quality goals on managerial decisions under the conditions of both accurate and erroneous feedback in allocating staff resources, and whether this leads to significant differences in project outcomes. Further, this research will examine the effects of Goal-discrepancy feedback (GDF) on project performance. GDF indicates whether subjects were performing above or below assigned goals, and by how much. Ref. 9 Even though research has been conducted into the affect of goals on software managers, no study on the interaction between feedback and goals on project managers using this type of tool has been published.

C. SCOPE OF RESEARCH

The scope of this research is the design, construction, and conduct of an experiment using the System Dynamics Model of Software Project Management to analyze the interaction between feedback and conflicting goals on software project managers. The System Dynamics Model of Software Project Management will be used to simulate the programming phase of an actual software project. Graduate students, representing software managers, will be divided into four groups and will be asked to make several decisions for

their project every 40 days throughout the programming phase of the project life cycle.

The four groups represent different combinations of projects and goal sets and will be designated as groups A1, A2, B1, and B2. The letter will indicate the project to be managed. Project A will be have accurate feedback throughout the programming phase. Project B will have erroneous feedback over estimating project completion until day 120. The number indicates the goal set. Goal set 1 is cost and schedule. Goal set 2 is quality and schedule.

Data will be collected on several dependent and independent variables after each 40 day period. This data will then be statistically analyzed to determine differences in decision making performance among the groups. The experiment will seek to investigate the following research questions: 1. What degree of influence do project feedback and goals have on a software project manager's staffing decisions? 2. How will project feedback and goals effect project outcome?

D. LIMITATIONS

The participants for this experiment were graduate students in their fifth quarter of an eight quarter graduate program leading to a MS degree in Information Technology Management at the Naval Postgraduate School in Monterey, California. Although these students are not actual software managers, they have received extensive education in software design and management. It is assumed that these students will perform comparable to professional software managers. This assumption is further supported by the findings of William Remus. [Ref. 5]

E. THESIS ORGANIZATION

Chapter II describes the software, and design of the documentation, as well as the design considerations taken into account during the creation of the experiment. Chapter III describes the experimental tasks, characteristics, organization, methodology, and experimental group. Chapter IV analyses the results. Chapter V summarizes the accomplishments and findings and provides suggestions for further research.

II. PREPARATION OF THE EXPERIMENTAL INTERFACE

A. EXPERIMENTAL DESIGN

The System Dynamics Model of Project Management enables the conduct of controlled software management experiments. Depending on the interface used, the model can be used to simulate any or all aspects of a software management project. Although the model is capable of simulating any phase of the software development life cycle, in this experiment, the system only mimics the development phase of a software project. That is, the period from the completion of the design phase to the beginning of the testing phase. The player, or subject, plays the role of manager of a software project. Prior to starting the game, the subject is given an instruction set that includes a specific goal set.

Two separate project scenarios were constructed to investigate decisions under both accurate feedback and erroneous feedback. Project A provided accurate real time feedback through out the experiment, while project B provided an overestimation of project completion until day 120 to the subject, and then provided accurate feedback. Project B's subjects were shown reports and graphs reflecting that they were further along in the project than they actually were. For each project, two goal combinations were used for experimental analysis. All combinations contained the element of schedule, for without a schedule constraint, dysfunctional behavior would most likely occur. Figure 2-1 is a chart that depicts the goal and project combinations.

	Cost and Schedule		Quality and Schedule	
Project A	A11	A12	A21	A22
Project B	B11	B12	B21	B22

Figure 2-1 Project/Goal Numbering Scheme

1. Cost and Schedule Goal Set

The first goal set is cost and schedule. "Cost and Schedule" was given the number 11. The identical goal set stated in the reverse order as "Schedule and Cost" is given the number 12. For example, goal A11 is stated as "Minimize overruns in both cost and schedule." Goal A12 is stated as "Minimize overruns in both schedule and cost."

2. Quality and Schedule Goal Set

The second combination is "Quality and Schedule" and is numbered 21. The identical goal set stated in the reverse order as "Schedule and Quality" is numbered 22. When this number is combined with the specific project the result is a three character alphanumeric that denotes the Project, Goal Set, and the Goal Order. For example, B12 denotes: Project B that has erroneous feedback, Goal set 1 of Cost and Schedule, and Order 2 that changes the ordering of the goal set to Schedule and Cost.

3. Feedback Treatment

Figure 2-2 is an example of a completed project A Progress Report Graph. During project A, accurate feedback was displayed to the manager about the percent of Delivered Source Instructions (DSI) that were complete. The forty-five degree angle line is the Planned Percent Completion Rate, which the manager could use to judge if they were either ahead or behind schedule by comparing their DSI reported complete to it. In this example the manager could tell early in the simulation that they were behind in the project, and could make their resource allocation decisions based on that knowledge.

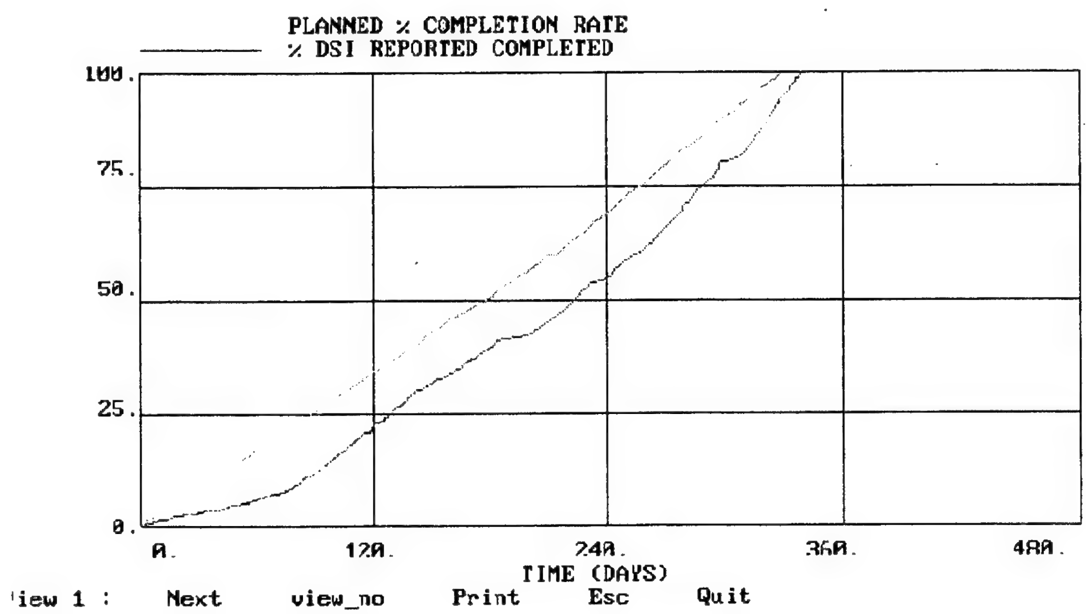


Figure 2-2 Accurate Feedback Example

Figure 2-3 is an example of a completed project B Project Report Graph. During Project B, erroneous feedback was displayed to the manager overestimating their projects DSI reported complete through day 120. In this example, the project manager was

unaware until day 120 that his project was significantly behind in completion. Because of this, he was much further along in the project when he realized that his critical staffing decisions and cost estimates were to low, and he had to begin making major adjustments to resource allocations in the middle of the project.

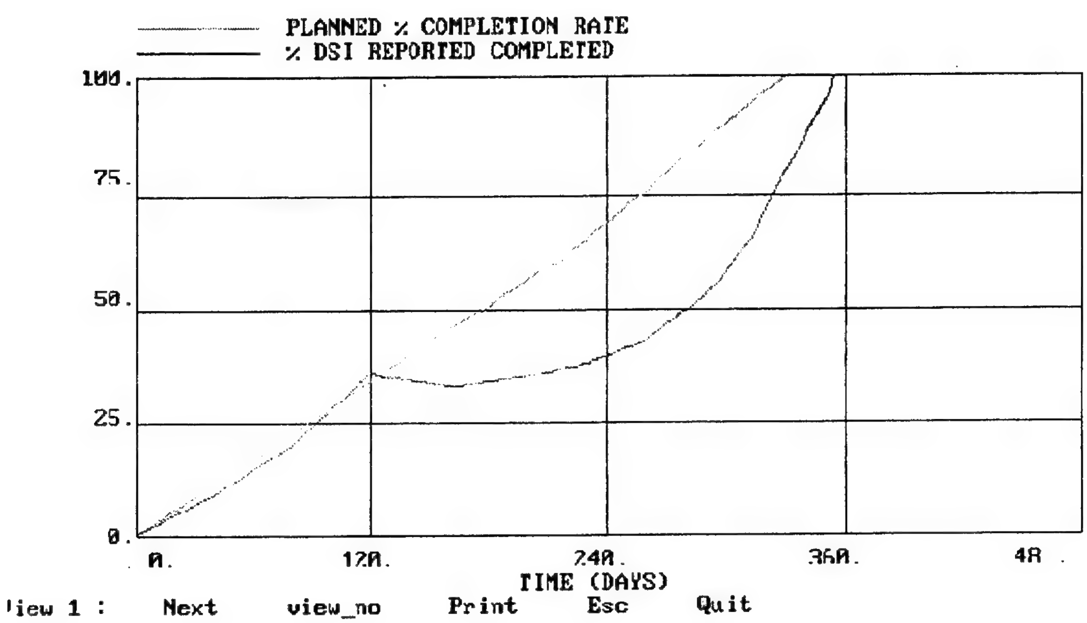


Figure 2-3 Erroneous Feedback Example

4. Experimental Groups

The experimental population had no previous experience with the SDM model. In order to prepare the subjects in running the simulation, each subject received a classroom lecture where the interface was demonstrated. During this period the subjects were told

that the experiment was "very real." For example, they understood that hiring delays, turnover, transfers, work force ceilings, and training delays would all affect the actual workforce number. After this training session, each subject performed a practice session named called the "TOY". Toy was a project that had no specific goal other than to familiarize the subject with the experiment. TOY remained constant in size. The purpose of the training session was familiarity with the gaming interface and to provide a constant level of experience across the experimental groups.

5. Independent and Dependent Variables

Each subject made five inputs at each interval throughout the experiment. They were the estimated programmer productivity, total workforce requested, the percent of this workforce dedicated to quality assurance, the estimated cost to complete the programming phase, and the estimated programming phase duration. The ten project outcome variables shown in Figure 2-4 were captured at the end of the project simulation.

VARIABLE	DESCRIPTION
FNCOST	Final Cost (in Man Days)
FNTIME	Final Cumulative Time (Days)
FNERR	Final Errors Remaining Undetected
FNERG	Final Cumulative Errors Generated
FNERD	Final Cumulative Errors Detected
FNERES	Final Cumulative Errors Escaping Detection
FNPRDT	Final Percentage of Errors Detected
FNQAMD	Final Cumulative Quality Assurance Man Days
FNTRMD	Final Cumulative Training Man Days
FNRWMD	Final Cumulative Rework Man Days

Figure 2-4 Project Outcome Variables

In addition, at each decision point in the simulation (i.e. every 40 days) 31

variables were automatically captured by the software. A detailed explanation of these variable is available in Ref. 7. These variables include the five decisions made by the subject plus the process variables on the specific type of report or graph that was viewed by the subject and the length of time that the information was presented on the screen. A detailed description of these variables in available in Ref. 7.

B. SOFTWARE AND DOCUMENTATION

In order to conduct the experiment, three distinct areas of components needed to be designed. The software interface for the experiment, the instructions for its use, and the questionnaire to be completed at the end of the experiment. Ref 7 provides a detailed explanation of how the software actually works.

1. Documentation

The documentation was considered critical to the experiment's success. The documentation for the experiment was in three parts. The first portion was termed the "Instruction Set" and contained the instructions that were specific to each of the eight experimental groups. The Instruction Set also contained a documentation page so that subjects could record their inputs incase of computer malfunction. Each subject also received a copy of the "Description of the Simulation Interface." This document contained general instructions on the meaning of reports and graphs, and how to operate the interface, i.e. view reports and graphs, and was distributed to each subject in their envelope at the beginning of both the Toy and Actual experiments. These two documents and the accompanying disk were placed in a large manilla envelope for each subject. The third part was the Project Questionnaire. The questionnaire was completed by each subject at the end of the actual experiment.

2. Instruction Set

An example instruction set distributed to the subjects with project/goal/order A11 appears as Appendix I. There were a total of nine different sets of instructions created.

One for the practice experiment, and one for each of the eight project/goal/order combinations.

3. Description of the Simulation Interface

The Description of the Simulation Interface appears as Appendix K. This document's intent was to help the subjects familiarize themselves with the user interface. The handout included an example of all of the reports and graphs available to the user between project intervals. A short description of the information was also included. This information was distributed prior to both the TOY and actual experiments in the manilla folder.

4. Project Questionnaire

Four versions of the Project Questionnaire were developed. An example version of the master appears as Appendix K. Each questionnaire had an X followed by the goal set/order combinations. For example X11 referred to either project A or B, goal set 1, order 1. X11 or X12 denotes that Question 1 would ask for the percentages concerning cost and schedule. X21 or X22 asked for percentages concerning quality and schedule. The order of the goal sets was added into the questionnaire to evaluate if goal order and demographics effected the experiment. All other questions were identical. The questionnaires were not included in the envelope that each subject received prior to conducting the experiment, but were retained by the lab attendants and distributed to the subjects at project completion. The questionnaires served to gather demographic data on the subjects, and to collect feedback concerning the conduct and performance of the experiment.

C. INTERFACE VALIDATION

In order to validate the user interface, pilot experiments were conducted using the lab attendants. The pilots were conducted at four separate sittings, allowing time to incorporate their suggestions between the sessions. Several improvements were implemented concerning clarity and organization of the report and graph screens.

Particular attention was paid to the scaling of the graphs. Every attempt was made not to influence subject's decisions by exaggerated scales on a graph.

D. FINAL PREPARATIONS

Having completed the interface design, documentation, and follow-up questionnaire, seven copies of each of the eight project disks were made. 15 copies of each of the four separate follow-up questionnaires were made. Individual envelopes were prepared for each participant and their name written on the outside. Signs were prepared and posted on the doors to both labs the evening before both days of experimentation to prevent nonparticipants from entering the lab during the conduct of the experiment.

III. CONDUCT OF THE EXPERIMENT

A. TASKS AND PROJECT CHARACTERISTICS

Having completed the practice experiment, all of the subjects were given an additional opportunity to ask questions prior to taking the actual experiment. Some questions were asked concerning whether there was any incentive to finish ahead of schedule. In response to these questions, the subjects were told the project that they were managing was a portion of a larger project. Finishing their portion early would only result in dead time for their staff. This left no questions that there was no reward for finishing early.

The subjects were reminded that they were to work alone and not to discuss anything with anyone other than the lab attendant. All participants were told that their performance on the experiment would be incorporated into their class participation portion of the grade for IS-4300.

B. ORGANIZATION OF THE EXPERIMENT

The introduction to the actual experiment consisted of a 15 minute training session in which each participant was given their personal envelope and informed of its contents. The experimental guidelines were reviewed for the last time. A seating chart was distributed to each subject and appears as Appendix N. None of the students with similar goals were seated next to each other. Prior to the experiment, all of the computers were checked to ensure the software would properly run. As noted in the Appendix N, several machines could not run the software and were not used. A final opportunity was provided to settle any last minute questions before the participants were directed to the lab.

The size of the experimental group required that two separate sessions, each session split in half and distributed across two labs with an hour in between to allow for separate group briefings. A lab assistant was present in each lab to ensure compliance with the seating chart and to provide general guidance throughout the experiment. Lab assistants had special copies of the seating chart that also indicated the project and goal set

of each subject. This was done in the event that any subject's computer might malfunction creating the need for reassignment. Reassignment could then be done ensuring subjects with similar goal sets were not seated side by side. The experiment designer served as the lab assistant in one lab and made periodic checks with the other lab attendant to ensure that all of the subject's concerns were being handled uniformly between the labs. The same persons served as lab attendants in both the Wednesday and Thursday sessions. Experimental groups were started an hour apart to allow for more individualized subject briefing. No information was given to the subjects on how to calculate staffing levels or how to interpret the reports. Both lab assistants had spare disks for each of the eight project configurations, and had back-up copies of all of the documentation. The entire experiment was conducted over two days. All subjects were completed with the experiment within two hours.

C. THE EXPERIMENTAL SUBJECTS

The subjects that participated in this experiment were students from two sections of the Software Engineering and Management course, IS-4300, taught at the Naval Postgraduate School. Section one consisted of 31 students and section two had 24 students. The subjects were randomized and assigned to each of the eight group sets in the following manner.

1. Random Number Assignment

Students in the two sections were listed sequentially in the order that they appeared on the registration roster. A standard list of random numbers was chosen (Daniel, 1975). The last three digits were used. Random numbers were assigned sequentially to each subject.

2. Project Assignment

The subjects were then sorted by their random number. Now that the subjects were in a random order, each was assigned a project in sequence. The projects were assigned in the order of A11, A12, A21, A22, B11, B12, B21, B22.

D. DEPENDENT MEASURES

Ten performance variables were captured at the completion of the experiment. Of these, three were the most indicative of performance and were used to evaluate project performance as the dependent variables. The first of these is Final Cost, FNCOST. (See Appendix O for the key to deciphering variable names). FNCOST is the cost in person days expended to complete the project.

The second dependent variable is the Final Time. FNTIME is the day that the project was completed. All subjects had the goal of completing the project within the estimated time.

The third, and last dependent variable is FNERR. FNERR is the value indicating the number of cumulative errors remaining in the software at project completion. This value indicated the quality of the software, i.e. fewer errors indicated a higher quality product.

IV. EXPERIMENTAL RESULTS AND ANALYSIS

A. MODEL OF ANALYSIS

For each subject, there were three sets of data captured during the simulation. Performance data measuring the project outcome was captured in the file PERFORM.DAT. Data was also captured on the five decisions made by a subject in each interval, and was stored in the file PROCESS.DAT. During each interval, data was captured on which report or graph subjects viewed and the length of time they viewed it. This data was written to the file named CAPTURE.DAT. The three data sets appear as Appendices A,B,C, respectively. Also, demographic data on each participant in the simulation was obtained through the use of a questionnaire contained in Appendix X.

Analysis of this data was conducted using Statistical Analysis System (SAS) software. Procedure MEANS, was used to determine the means and significance. Procedure General Linear Model (GLM) was used for multi variate analyses. Procedure Correlation was used to detect any correlation between independent and dependent variables. The SAS program files appear in Appendix P.

B. PERFORMANCE DATA

The analysis of each participants final performance focused on three dependent variables final cost, final schedule, and final errors. Figure 4-1 depicts the means and standard deviations of the performance variables for the different experimental groups.

	FNSKED,Mean and (Std. Dev)	FNCOST, Mean and (Std. Dev)	FNERR, Mean and (Std. Dev)
Project A - Cost and Schedule	302 (41)	1518 (355)	2863 (3324)
Project A - Quality and Schedule	292 (43)	1737 (319)	1190 (648)
Project B - Cost and Schedule	295 (47)	1451 (257)	1463 (581)
Project B - Quality and Schedule	347 (65)	2006 (278)	847 (386)

Figure 4-1 Performance Means and Standard Deviations for the Groups

	FNSKED,Mean and (Std. Dev)	FNCOST, Mean and (Std. Dev)	FNERR, Mean and (Std. Dev)
Cost and Schedule All Projects	298.3 (42.9)	1483.0 (300.0)	2126.2 (2365.2)
Quality and Schedule All Projects	320.7 (60.7)	1878.3 (321.0)	1009.7 (540.6)
Project A both goal sets	296.9 (346.1)	1627.6 (346.1)	2026.4 (2477.4)
Project B both goal sets	320.9 (60.9)	1728.5 (385.9)	1155.4 (574.8)

Figure 4-1a Performance Means and Standard Deviations by goals and projects

1. Means

The analysis of the above means from Figure 4-1 reveals that all goals were important to the subjects. The mean of the groups that had quality as a goal had fewer errors than those groups that did not. The same holds true for those subjects that had cost as a goal, those groups had lower mean costs than the groups without cost as a goal. Everyone had minimizing schedule as a goal, so it is not surprising there was not a substantial difference between groups with respect to schedule. The data in figure 4-1a showed that the bad feed back of project B definitely increased the mean project schedule and cost, as compared to project A. Peculiarly, though, the bad feedback of project B led to a better quality product, this was because as subjects with quality as a goal felt they were on or ahead of schedule due to erroneous feed back, they put more staff into quality assurance to attain a quality product.

a. Evaluation of variables

The GLM procedure was used for comparison of the groups performance to determine if there were significant differences between the groups. Each group's cost, schedule and quality variables were analyzed to determine if they were significant. Then the effects of goals and feedback were analyzed on the above variables.

b. Cost

For final cost, the GLM procedure yielded $(F(4,33)=7.00; P<0.0003)$. This rejects the null hypothesis, thereby that indicating there were significant differences among the four experimental groups in terms of cost. Also, there was a strong goals effect $(F(4,33)=17.39; P<0.0002)$ on cost. Subjects that had minimizing cost as a goal had significantly lower costs compared to subjects that did not have cost as a goal. There was not, however, a feedback effect $(F(4,33)=1.48; P<.2839)$, the erroneous feedback given to a subject working on project B did not significantly effect his/her cost.

c. Schedule

For final schedule the GLM procedure produced $(F(4,33)=3.24; P<.0239)$. This rejects the null hypothesis thereby indicating that there were significant differences

between groups in terms of schedule. All subjects had the goal of minimizing schedule, so there was not a goals effect between groups. However, the order of the goals on the subjects instruction sets seemed to have an effect, ($F(4,33)=3.24$; $P<.040$) this was probably due to the small number of subjects in each experimental group. The erroneous feedback given to a subject working on project B, though, did not significantly effect his/her final schedule ($F(4,33)=2.77$; $P<.1058$).

d. Quality

The GLM procedure for final errors revealed ($F(4,33)=3.26$; $P<0.0233$) rejecting the null hypothesis thereby indicating significance. There was a significant difference between groups in terms of quality. Again, there was a strong goals effect ($F(4,33)=4.85$; $P<0.0348$). Subjects that had maximizing quality as a goal delivered a product with fewer errors than subjects who did not have maximizing quality as a goal. The order of the goals was also significant ($F(4,33)=4.57$; $P<0.0401$), but again, this was probably due to the small number of subjects in each experimental group. However, the erroneous feedback of project B did not significantly effect it in terms of quality ($F(4,33)=3.21$; $P<.0823$), although, the group with erroneous feed back and quality as a goal did have the best quality product.

C. PROCESS DATA

The subjects were required to make five decisions at each 40 day interval. The first decision was to estimate the productivity of the team (lines of code produced per programmer per day). Then each subject selected his/her total staff, percentage of staff allocated to quality assurance, and estimates of the projects' final cost and schedule. The actual completion time of the project was dependent on the particular decisions made by the manager. In graphing the group means of the process data obtained, the last interval used is day 200. This is the last interval in which all of the subjects had not completed the project and were still making decisions. An analysis using the SAS GLM procedure was used to determine if there was a period effect, second to determine if there was a time effect between the four groups, and also to determine if there was significant difference

between the subjects of the four groups.

Three types of analyses were conducted on the means of the process data. The first was to determine if there is a period effect, i.e. the values changed over time. Next, the data was analyzed to determine if there was interaction between the groups with different goals over time. Lastly, analysis was conducted to determine if there was significant difference between subjects.

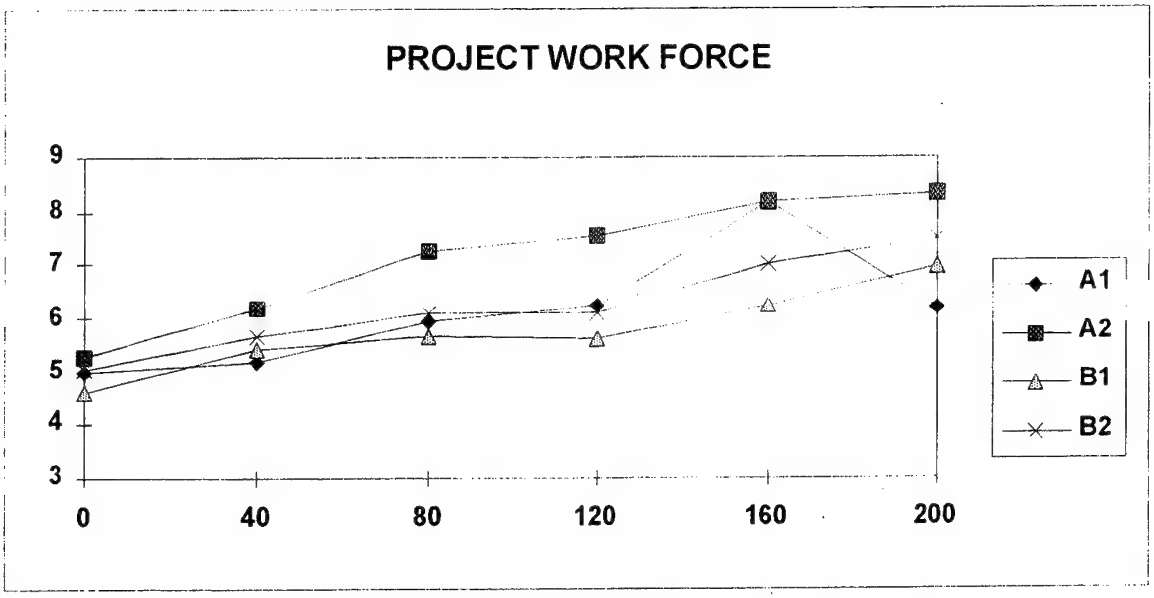


Figure 4-2 Total Staff Requested for Project.

a. Total Staff

Figure 4-2 is a graph of the group means for total staff requested by participants in the Project. The analysis of the means as shown in the graph indicates that there is a period effect. The null hypothesis for no period effect is rejected with respect to staff ($F(5,31)=5.84$; $P<0.0007$). The null hypothesis for interaction however, cannot be rejected ($F(5,31)=1.52$; $P<0.2211$). The test for difference between subjects indicates that the null hypothesis cannot be rejected, there is no significant difference between subjects with different goals ($F(1,35)=4.05$; $P<0.052$), or feed back ($F(1,35)=1.14$; $P<0.290$).

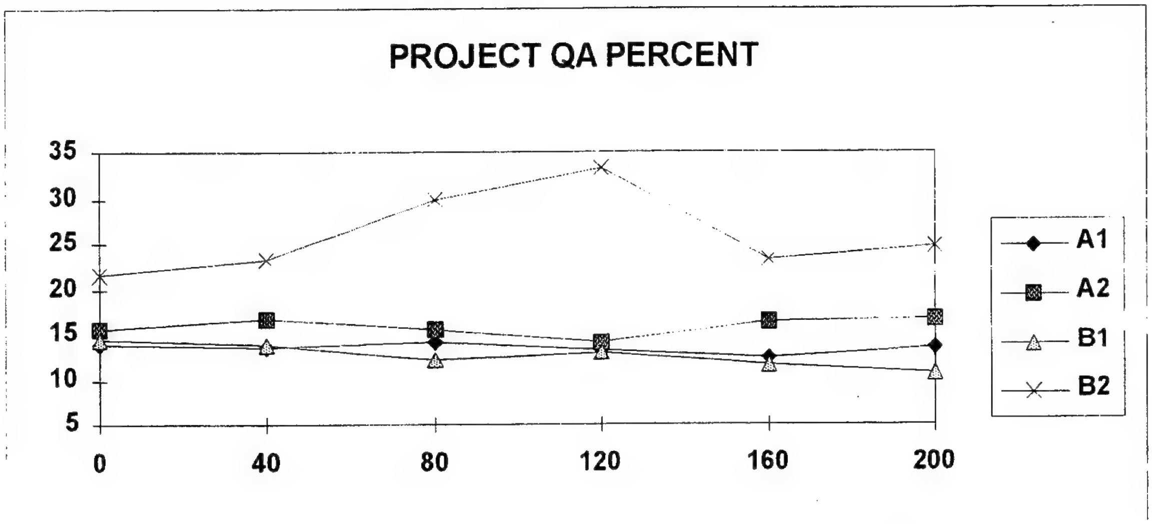


Figure 4-3 Percent of Requested Staff Allocated to QA for Project

b. Quality Assurance

Figure 4-3 is a graph of the percent of the total staff allocated to quality assurance activities. The analysis of the means as shown in the graph indicates that there is no period effect with respect to quality assurance. The null hypothesis for no period effect is accepted with respect to quality assurance ($F(5,31)=5.84$; $P<0.336$). Also, the null hypothesis for interaction between groups over time cannot be rejected ($F(5,31)=1.41$; $P<0.249$). The test for difference between subjects indicates that the null hypothesis can be rejected , there is significant difference between subjects with different goals ($F(1,35)=8.35$; $P<0.052$). For between subjects effects on feed back, however the null hypothesis cannot be rejected ($F(1,35)=2.71$; $P<0.111$). Feedback was not significant with respect to quality assurance.

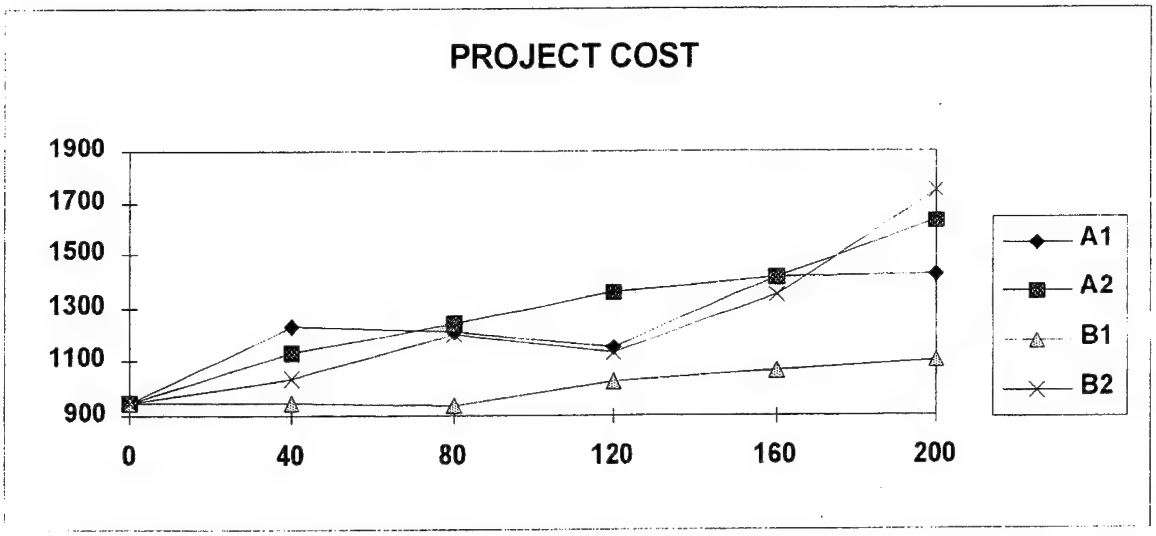


Figure 4-4 Estimated Completion Cost for Project

c. Cost Estimates

Figure 4-4 depicts the estimate for total project cost for the subjects that managed Project. The analysis of the means as shown in the graph indicates that there is a period effect with respect to cost. The null hypothesis for no period effect is rejected with respect to cost estimates ($F(5,31)=8.11$; $P<0.0001$). However, the null hypothesis for interaction between groups cannot be rejected ($F(5,31)=1.74$; $P<0.155$). The test for difference between subjects indicates that the null hypothesis can not be rejected, indicating that there is no significant difference between subjects with different goals ($F(1,35)=2.70$; $P<0.110$) or feed back ($F(1,35)=2.36$; $P<0.133$).

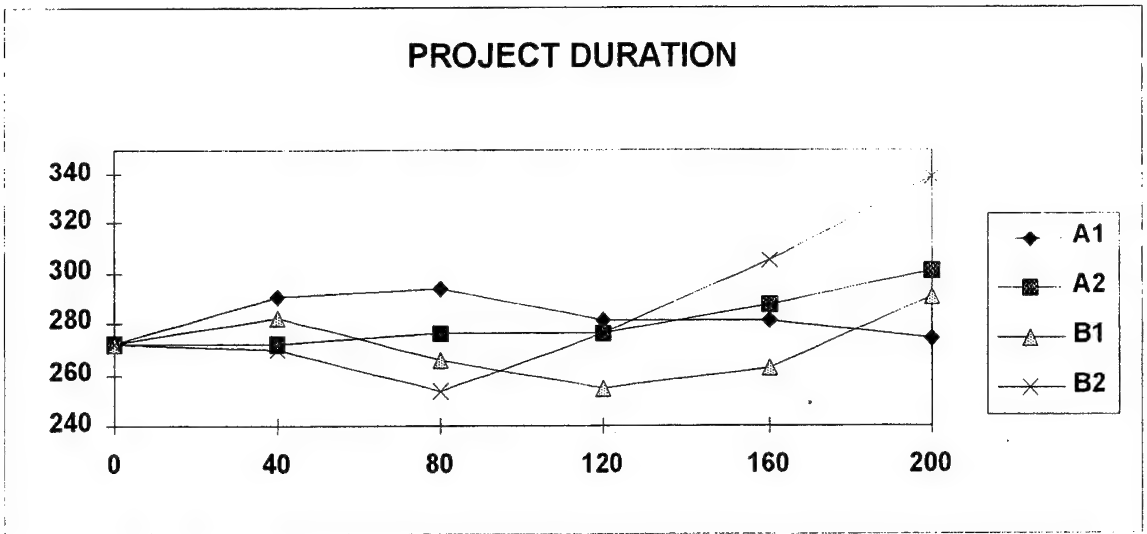


Figure 4-5 Estimated Schedule for Project.

d. Schedule Estimates

Figure 4-5 illustrates the subject's estimated project schedule as the project progressed. The analysis of the means as shown in the graph indicates that there is no period effect. The null hypothesis for no period effect can not be rejected with respect to schedule estimates ($F(5,31)=2.13$; $P<0.089$). Also, the null hypothesis for interaction between groups cannot be rejected ($F(5,31)=1.52$; $P<0.214$). The test for difference between subjects indicates that the null hypothesis can not be rejected, indicating that there is no significant difference between subjects with different goals ($F(1,35)=.74$; $P<0.396$) or feed back ($F(1,35)=0.11$; $P<0.739$).

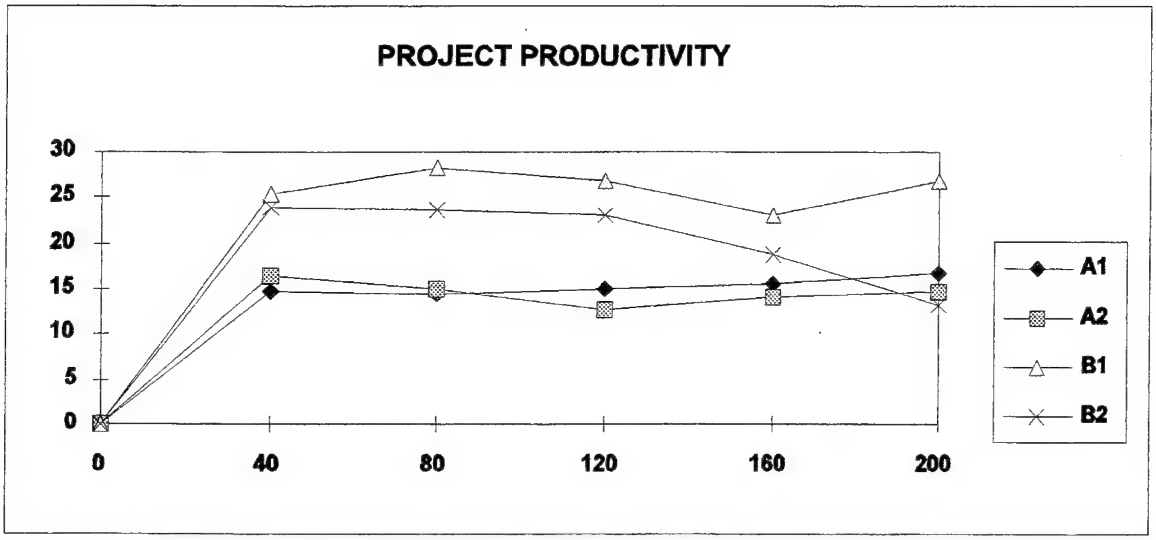


Figure 4-6 Estimated Productivity for Project.

e. Productivity Estimates

Figure 4-6 is a graph of the group means for individual staff productivity estimated by participants in the Project. The analysis of the means as shown in the graph indicates that there is a period effect. The null hypothesis for no period effect is rejected with respect to staff productivity ($F(5,31)=320$; $P<0.0001$). The null hypothesis for interaction between groups however, cannot be rejected ($F(5,31)=2.22$; $P<0.077$). The test for between subjects effects with different goals indicates that the null hypothesis cannot be rejected ($F(1,35)=3.31$;$P<0.078$). However, the between subjects effects for different feed back were significant rejecting the null hypothesis ($F(1,35)=21.23$; $P<0.0001$).

D. QUESTIONNAIRE AND DEMOGRAPHIC DATA

After completion of the project, each participant filled out a questionnaire. The last page of the questionnaire was devoted entirely to demographics. The data format can be found in Appendix Q.

Group	AGE	CHRSWK	WKEXP	EDAGO
A1	33.0 (2.8)	23.4 (9.7)	13.0 (5.5)	11.9 (6.3)
A2	31.9 (3.1)	15 (6.9)	10.8 (4.8)	8.3 (4.0)
B1	31.6 (4.1)	13.6 (7.0)	11.5 (4.7)	7.4 (5.1)
B2	30.2 (3.7)	19.9 (13.0)	8.4 (4.9)	7.4 (3.8)

Figure 4-7 Group means and standard deviation demographics

Figure 4.7 represents the sample demographics profile by group. Age represents the average age of the participant, CHRSWK represents the mean number of hours spent using a computer per week, WKEXP represents work experience in years, and EDAGO is the number of years since the subject completed his undergraduate education. Group A1 was the oldest, had the most work experience, spent the most time on a computer per week, and had completed their undergraduate education the longest ago. Group B2 was the youngest spent the second greatest time on a computer per week and tied with group B2 for having the most recent undergraduate experience.

V. CONCLUSIONS

A. FINDINGS AND IMPLICATIONS

The objective of this thesis was to conduct a controlled experiment focused on gaining insight into the interaction between feedback and stated goals on software project management. This thesis provides significant findings regarding the software project managers's behavior in both accurate and erroneous feedback environments.

The experimental results confirm that goals do matter to software development managers. Managers perform best in the goals that they are given. Additionally, it confirms that different software development goals, i.e. quality, cost, and schedule are indeed in conflict with each other.

The experimental results did not, however, find any significant differences between the groups given different feedback. Only two reasons for this exist, either goals overwhelm feedback, or more than likely, the small group size of this experiment caused the feedback results to be insignificant.

B. FURTHER RESEARCH

There are several more areas that can be researched using the Systems Dynamic Model of Software Project Management. One particular area would be to conduct the experiment with professional software manages to see if they respond similarly to stated goals. Project outcome could differ when managed by professional managers.

Another area to be researched concerns goal commitment. In this thesis goals were given to the manager and no attempt was made to analyze the level of commitment. Further research could be conducted to measure both the initial commitment to the goals and whether this commitment was maintained over time.

Lastly, interaction between feedback and goal commitment could be researched using more subjects. In this thesis, there were differences in performance that occurred due to feedback, but the group size was to small for them to be significant.

APPENDIX A. PROJECT@.BAT

```
@echo off
rem PROJA initially underestimated project

cls
rem init.exe requires 3 parameters i.e. [project,group,ins.set]
init A 1 2
graphics
bat /n /p /s
ram
smlt PROJA -go = -prs = -ls -ns -plm 16
rep PROJA.RSL PROCESS.DRS -outf PROCESS.OUT -t >NUL
rep PROJA.RSL PROCESS.DRS -outf PROCESSS.OUT -t >NUL


-top    dynex PROJA -in PROJA.STT -sc -ls -plm 16
      smlt PROJA -gm = -ns -plm 16

      copy process.out process.old >NUL
      rep PROJA.RSL PROCESS.DRS -outf PROCESS.OUT -t >NUL
      rep PROJA.RSL PROCESS.DRS -outf PROCESSS.OUT >NUL
      rep PROJA.RSL INTERVAL.DRS -outf INTERVAL.OUT -t >NUL
      process

      call -top1
      rep PROJA.RSL PERFORM.DRS -outf PERFORM.OUT -t >NUL
      perform
      rem finish
      exit

-top1   cls


-PROGREP **** VIEW PROGRESS ********************************
      timestmp
      rep PROJA PROGRESS.DRS -outf PROGRESS.OUT -t -sc -ls -plm 16
      inkey
      capture R5 >NUL
      cls
      color \1F



-menu
      color \1F
      cls
      begtype
```

```
                         REPORTS AND GRAPHS MENU

\1EREPORTS: \1F
            \1E 1    \1F PROJECT STATUS \1EREPORT\1F


            \1E 2    \1F STAFFING \1EREPORT\1F


            \1E 3    \1F DEFECT \1EREPORT\1F


            \1E 4    \1F CUMULATIVE \1EREPORT\1F


\1BGRAPHS:  \1F

            \1B 5    \1F PROJECT PROGRESS \1BGRAPH\1F


            \1B 6    \1F STAFFING \1BGRAPH\1F


            \1B 7    \1F COST AND DURATION \1BGRAPH\1F

            \1B 8    \1F DEFECT STATUS \1BGRAPH\1F


     PRESS  \1D P    \1F TO \1DPROCEED\1F TO ENTER DECISIONS FOR THE NEXT 40 DAYS



     Choose an option: (Do NOT hit <ENTER> after selection!!!);


end

-1stkey1 inkey %2 | type %2;
      if %2 = 1 goto -STATREP
      if %2 = 2 goto -STAFREP
      if %2 = 3 goto -DEFREP
      if %2 = 4 goto -CUMREP
      if %2 = 5 goto -FEEDPLOT
      if %2 = 6 goto -STAFPLOT
      if %2 = 8 goto -DEFPLOT
```

```
        if %2 = 7 goto -COSTPLOT
        if %2 = P goto -proceed
        if %2 = KEY011 return
        beep goto -menu


-STATREP **** VIEW PROJECT STATUS REPORT ********************
        timestmp
        rep PROJA STATUS.DRS -outf STATUS.OUT -t -sc -ls -plm 16
        inkey
        capture R1 >NUL
        cls
        color \1F
        goto -menu



-STAFREP  **** VIEW STAFFING REPORT ********************
        timestmp
        rep PROJA STAFFING.DRS -outf STAFFING.OUT -t -sc -ls -plm 16
        inkey
        capture R2 >NUL
        cls
        color \1F
        goto -menu


-DEFREP  **** VIEW DEFECT REPORT ********************
        timestmp
        rep PROJA DEF.DRS -outf DEF.OUT -t -sc -ls -plm 16
        inkey
        capture R3 >NUL
        cls
        color \1F
        goto -menu

-CUMREP **** VIEW PROJECT CUMULATIVE REPORT ********************
        timestmp
        rep PROJA CUM.DRS -outf CUM.OUT -t -sc -ls -plm 16
        inkey
        capture R4 >NUL
        cls
        color \1F
        goto -menu
```

```
-COSTPLOT **** VIEW PROJECT STATUS PLOT ****
     timestmp
     cls
     color \1F
     begtype



******************************************************************************
  \1A                  PROJECT COST VARIABLES                            \1F
******************************************************************************

       THE FOLLOWING PROJECT STATUS VARIABLES WILL BE PLOTTED:


  EST OF PROGRAMMING PHASE COST. . . . . . . . PERSON DAYS
  EST OF PROGRAMMING PHASE DURATION  . . . . . DAYS




  \1A     AFTER VIEWING PLOT PRESS <ESC> TO RETURN TO THE MENU  \1F




  \1A     PRESS <ENTER> TO VIEW PLOT   \1F


end
     inkey
     cls
     rep PROJA STATPLOT.DRS
     capture G8 >NUL
     color \1F
     cls
     goto -menu


-STAFPLOT **** VIEW GRAPHIC STAFFING PLOT ****
     timestmp
     cls
     color \1F
     begtype
```

```
******************************************************************************
  \1A                       STAFFING VARIABLES                    \1F
******************************************************************************

        THE FOLLOWING STAFFING VARIABLES WILL BE PLOTTED:


    TOTAL STAFF . . . . . . . . TOTAL STAFF LEVEL
    QA STAFF. . . . . . . . . . NUMBER OF PERSONS ALLOCATED TO QA
    PROG STAFF. . . . . . . . . NUMBER OF PERSONS DOING PROGRAMMING



  \1A     AFTER VIEWING PLOT PRESS <ESC> TO CONTINUE   \1F



  \1A     PRESS <ENTER> TO VIEW PLOT    \1F


end
      inkey
      cls
      rep PROJA STAFPLOT.DRS
      capture G6 >NUL
      color \1F
      cls
      goto -menu


-DEFPLOT **** VIEW DEFECT PLOT ****
      timestmp
      cls
      color \1F
      begtype



******************************************************************************
  \1A                        DEFECT VARIABLES                   \1F
******************************************************************************

       THE FOLLOWING DEFECT VARIABLES WILL BE PLOTTED:
```

```
    QA PERSON DAYS PER PERIOD . . . . QA PERSON DAYS EXPENDED PER PERIOD
    DEFECTS DETECTED PER PERIOD . . . DEFECTS DETECTED PER PERIOD




  \1A     AFTER VIEWING PLOT PRESS <ESC> TO RETURN TO THE MENU  \1F




  \1A     PRESS <ENTER> TO VIEW PLOT   \1F


END
      inkey
      cls
      rep PROJA DEFPLOT.DRS
      capture G7 >NUL
      color \1F
      cls
      goto -menu

-FEEDPLOT **** VIEW DEFECT PLOT ****
      timestmp
      cls
      color \1F
      begtype




*********************************************************************************
   \1A                  PERCENT COMPLETION VARIABLES                    \1F
*********************************************************************************

       THE FOLLOWING VARIABLES WILL BE PLOTTED:


    PLANNED PERCENTAGE COMPLETION RATE . . . PERCENT KDSI
    PERCENT DSI REPORTED COMPLETE  . . . . . PERCENT KDSI
```

```
  \1A     AFTER VIEWING PLOT PRESS <ESC> TO RETURN TO THE MENU   \1F



  \1A     PRESS <ENTER> TO VIEW PLOT    \1F


END
      inkey
      cls
      rep PROJA FEEDPLOT.DRS
      capture G5 >NUL
      color \1F
      cls
      goto -menu


-proceed   **** PROCEED WITH NEXT SIMULATION ********************
      cls
      color \1F
      begtype




            *************************************************
            *            Press <ENTER> to continue          *
            *************************************************


end
goto -top


-on.error-
 if %R > 82 if %R < 90 type !! Floating Point Error !! |goto -Calc.
 Cls beep type Unexpected batch file error %R in line %L |exit
```

APPENDIX B. PROJ@.DNX

```
if #tm<.1 then
display clear

             *************************************
             !!!! Important Points to Remember !!!!
             *************************************

    - You are not allowed to discuss this exercise with anyone other
      than the lab attendant.  Please refrain from discussing this with
      members in the other class until they have completed the exercise.

    - The system will show you the size of the initial core team of
      software developers who have just completed the requirements/design
      specifications. You will then be asked for your desired staffing level
      for the programming phase. Then, the system will run through the
      first simulation time period (40 working days) and allow you to view
      various reports and graphs.  You will then be allowed to update your
      estimates for project cost and duration and change your staffing levels.

    - Record your decision for each interval on the documentation sheet
      provided before proceeding to the next interval.


      THE LAB ATTENDANT MUST VERIFY YOUR FINAL RESULTS!

    - GOOD LUCK!        Press <ENTER> to continue.
dendq
choice 1
cend 1/1


display clear

  **********************************************************************
  *               INITIAL ESTIMATES FOR THIS PROJECT:                  *
  *          System Size                      24400. DSI               *
  *          Cost of Programming Phase          #TOTMD1  Person Days   *
  *          Duration of Programming Phase      #TDEV  Days            *
  *                                                                    *
  *     The initial core team of software developers who have just     *
  *     completed the requirements and design specifications is        *
  *     #WFS1 people.                                                  *
  *                                                                    *
  *     Your task is to take over as manager of the programming phase. *
  *     At this point, you need to make 2 decisions:                   *
  *                                                                    *
  *     1.  The total staff level for the programming phase.           *
```

```
*                                                                         *
*     2.  The percent of this staff to allocate to Quality Assurance.     *
***************************************************************************

 -----> FIRST DECISION: The total staff level

     Enter your total requested staff level and press <ENTER>.
dendq
dq WFS1=0.5<
display clear


     -----> SECOND DECISION:

     NEW_TOOL's estimate for the percent of the total staff to allocate to QA
     is #FRMPQA percent. Remember, NEW_TOOL has not yet been calibrated to your
     environment.  Thus, this estimate is merely illustrative.  It may or may
     not be appropriate for your unique project.

     1) Enter a different desired percentage (a number from 0 - 100)
      and press <ENTER>.

                               OR

     2) Press <ENTER> to allocate #FRMPQA percent of your staff to QA.

dendq
dq FRMPQA=0<100

display clear

Your total requested staffing level =           #WFS1 people.

The percent to be devoted to QA activities =   #FRMPQA percent.
(This means that you are devoting #WFS1 * #FRMPQA / 100  = #WFS1*FRMPQA/100 people
to QA)


         *******************************************************
         *                  !!  IMPORTANT  !!                  *
         *                                                     *
         *     This is your final opportunity to check and     *
         *     change the values for this period.              *
         *                                                     *
         *     Press 1 then <ENTER> to change these values.    *
         *                                                     *
         *     If all values are correct, record them on       *
         *     the documentation sheet provided then           *
         *                                                     *
         *     Press 2 then <ENTER> to continue.               *
         *                                                     *
```

```
        *****************************************************

dend
choice 2

display
Your total requested staffing level =
dendq
dq WFS1=0.5<

display
The percent allocated to QA =
dendq
dq FRMPQA=0<100

cend
cend


else


choice 1
cend 1/1
display clear
           ************************************************
           *   Make Your Desired Changes To The Variables   *
           *                and press <ENTER>                *
           *                      OR                         *
           *    Press <ENTER> to keep the displayed value    *
           ************************************************

Your updated estimate for productivity (DSI/person days) =
dendq
dq PRODTY=0<

display
Your updated estimate for project cost (person days) =
dendq
dq TOTMD1=0<

display
Your updated estimate for project duration (days) =
dendq
dq PROJDR=0<

display
Your total requested staffing level =
dendq
dq WFS1=0.5<
```

```
display
The percent to allocate to QA (a number from 0 - 100) =
dendq
dq FRMPQA=0<100


display clear

Your updated estimate for productivity =          #PRODTY DSI/person-day
Your updated estimate for project cost =          #TOTMD1  person days
Your updated estimate for project duration =      #PROJDR days
Your total requested staffing level =               #WFS1 people
The percent to be devoted to QA activities =       #FRMPQA percent
(This means that you are devoting #WFS1 * #FRMPQA / 100  = #WFS1*FRMPQA/100 people
to QA)
```

```
        *********************************************************
        *                   !!  IMPORTANT  !!                   *
        *                                                       *
        *     This is your final opportunity to check and       *
        *     change the values for this period.                *
        *                                                       *
        *     Press 1 then <ENTER> to change these values.      *
        *                                                       *
        *     If all values are correct, record them on         *
        *     the documentation sheet provided then             *
        *                                                       *
        *     Press 2 then <ENTER> to continue.                 *
        *                                                       *
        *********************************************************

dend
choice 2

display
Your updated estimate for productivity (DSI/person days) =
dendq
dq PRODTY=0<

display
The updated estimate for project cost (person days) =
dendq
dq TOTMD1=0<

display
The updated estimate for project duration (days) =
dendq
dq PROJDR=0<

display
Your total requested staffing level =
dendq
dq WFS1=0.5<

display
The percent allocated to QA =
dendq
dq FRMPQA=0<100

cend
cend


end
display clear
```

```
     ************************************************************************
     *                                                                      *
     *   Press <ENTER> to simulate this interval and return to the menu.    *
     *                                                                      *
     ************************************************************************
dendq
choice 1
display clear



                ********************************************
                *                                          *
                *                                          *
                *    There will be a short pause while     *
                *    the model simulates the next period.  *
                *                                          *
                *                                          *
                ********************************************

dendq
report
time=maxtime,
cend 1/1

spec md_length=#length+40
```

APPENDIX C. TOY. BAT

```
@echo off
rem PROJA initially underestimated project

cls
rem init.exe requires 3 parameters i.e. [project,group,ins.set]
init A 1 2
graphics
bat /n /p /s
ram
smlt PROJA -go = -prs = -ls -ns -plm 16
rep PROJA.RSL PROCESS.DRS -outf PROCESS.OUT -t >NUL
rep PROJA.RSL PROCESS.DRS -outf PROCESSS.OUT -t >NUL


-top    dynex PROJA -in PROJA.STT -sc -ls -plm 16
      smlt PROJA -gm = -ns -plm 16

      copy process.out process.old >NUL
      rep PROJA.RSL PROCESS.DRS -outf PROCESS.OUT -t >NUL
      rep PROJA.RSL PROCESS.DRS -outf PROCESSS.OUT >NUL
      rep PROJA.RSL INTERVAL.DRS -outf INTERVAL.OUT -t >NUL
      process

      call -top1
      rep PROJA.RSL PERFORM.DRS -outf PERFORM.OUT -t >NUL
      perform
      rem finish
      exit

-top1   cls


-PROGREP **** VIEW PROGRESS *********************************
      timestmp
      rep PROJA PROGRESS.DRS -outf PROGRESS.OUT -t -sc -ls -plm 16
      inkey
      capture R5 >NUL
      cls
      color \1F



-menu
      color \1F
      cls
      begtype
```

```
                         REPORTS AND GRAPHS MENU

\1EREPORTS:  \1F
             \1E 1    \1F PROJECT STATUS \1EREPORT\1F

             \1E 2    \1F STAFFING \1EREPORT\1F

             \1E 3    \1F DEFECT \1EREPORT\1F

             \1E 4    \1F CUMULATIVE \1EREPORT\1F

\1BGRAPHS:   \1F
             \1B 5    \1F PROJECT PROGRESS \1BGRAPH\1F

             \1B 6    \1F STAFFING \1BGRAPH\1F

             \1B 7    \1F COST AND DURATION \1BGRAPH\1F

             \1B 8    \1F DEFECT STATUS \1BGRAPH\1F

     PRESS   \1D P    \1F TO \1DPROCEED\1F TO ENTER DECISIONS FOR THE NEXT 40 DAYS

     Choose an option: (Do NOT hit <ENTER> after selection!!!);

end

-1stkey1 inkey %2 | type %2;
      if %2 = 1 goto -STATREP
      if %2 = 2 goto -STAFREP
      if %2 = 3 goto -DEFREP
      if %2 = 4 goto -CUMREP
      if %2 = 5 goto -FEEDPLOT
      if %2 = 6 goto -STAFPLOT
      if %2 = 8 goto -DEFPLOT
      if %2 = 7 goto -COSTPLOT
```

```
      if %2 = P goto -proceed
      if %2 = KEY011 return
      beep goto -menu


-STATREP **** VIEW PROJECT STATUS REPORT ********************
      timestmp
      rep PROJA STATUS.DRS -outf STATUS.OUT -t -sc -ls -plm 16
      inkey
      capture R1 >NUL
      cls
      color \1F
      goto -menu


-STAFREP  **** VIEW STAFFING REPORT ********************
      timestmp
      rep PROJA STAFFING.DRS -outf STAFFING.OUT -t -sc -ls -plm 16
      inkey
      capture R2 >NUL
      cls
      color \1F
      goto -menu


-DEFREP  **** VIEW DEFECT REPORT ********************
      timestmp
      rep PROJA DEF.DRS -outf DEF.OUT -t -sc -ls -plm 16
      inkey
      capture R3 >NUL
      cls
      color \1F
      goto -menu

-CUMREP **** VIEW PROJECT CUMULATIVE REPORT ********************
      timestmp
      rep PROJA CUM.DRS -outf CUM.OUT -t -sc -ls -plm 16
      inkey
      capture R4 >NUL
      cls
      color \1F
      goto -menu
```

```
-COSTPLOT **** VIEW PROJECT STATUS PLOT ****
      timestmp
      cls
      color \1F
      begtype



********************************************************************************
  \1A                       PROJECT COST VARIABLES                        \1F
********************************************************************************

         THE FOLLOWING PROJECT STATUS VARIABLES WILL BE PLOTTED:


  EST OF PROGRAMMING PHASE COST. . . . . . . . PERSON DAYS
  EST OF PROGRAMMING PHASE DURATION  . . . . . DAYS




  \1A     AFTER VIEWING PLOT PRESS <ESC> TO RETURN TO THE MENU  \1F



  \1A     PRESS <ENTER> TO VIEW PLOT    \1F


end
      inkey
      cls
      rep PROJA STATPLOT.DRS
      capture G8 >NUL
      color \1F
      cls
      goto -menu

-STAFPLOT **** VIEW GRAPHIC STAFFING PLOT ****
      timestmp
      cls
      color \1F
      begtype
```

```
********************************************************************************
   \1A                        STAFFING VARIABLES                        \1F
********************************************************************************

         THE FOLLOWING STAFFING VARIABLES WILL BE PLOTTED:


    TOTAL STAFF . . . . . . . . TOTAL STAFF LEVEL
    QA STAFF. . . . . . . . . . NUMBER OF PERSONS ALLOCATED TO QA
    PROG STAFF. . . . . . . . . NUMBER OF PERSONS DOING PROGRAMMING



  \1A     AFTER VIEWING PLOT PRESS <ESC> TO CONTINUE   \1F



  \1A     PRESS <ENTER> TO VIEW PLOT   \1F


end
      inkey
      cls
      rep PROJA STAFPLOT.DRS
      capture G6 >NUL
      color \1F
      cls
      goto -menu


-DEFPLOT **** VIEW DEFECT PLOT ****
      timestmp
      cls
      color \1F
      begtype



********************************************************************************
   \1A                        DEFECT VARIABLES                        \1F
********************************************************************************

       THE FOLLOWING DEFECT VARIABLES WILL BE PLOTTED:


    QA PERSON DAYS PER PERIOD . . . . QA PERSON DAYS EXPENDED PER PERIOD
    DEFECTS DETECTED PER PERIOD . . . DEFECTS DETECTED PER PERIOD
```

```
  \1A      AFTER VIEWING PLOT PRESS <ESC> TO RETURN TO THE MENU   \1F



  \1A      PRESS <ENTER> TO VIEW PLOT    \1F


END
      inkey
      cls
      rep PROJA DEFPLOT.DRS
      capture G7 >NUL
      color \1F
      cls
      goto -menu

-FEEDPLOT **** VIEW DEFECT PLOT ****
      timestmp
      cls
      color \1F
      begtype



********************************************************************************
   \1A                    PERCENT COMPLETION VARIABLES                   \1F
********************************************************************************

       THE FOLLOWING VARIABLES WILL BE PLOTTED:


    PLANNED PERCENTAGE COMPLETION RATE . . . PERCENT KDSI
    PERCENT DSI REPORTED COMPLETE  . . . . . PERCENT KDSI





  \1A      AFTER VIEWING PLOT PRESS <ESC> TO RETURN TO THE MENU   \1F
```

```
  \1A     PRESS <ENTER> TO VIEW PLOT    \1F


END
      inkey
      cls
      rep PROJA FEEDPLOT.DRS
      capture G5 >NUL
      color \1F
      cls
      goto -menu


-proceed  **** PROCEED WITH NEXT SIMULATION ********************
      cls
      color \1F
      begtype




            *************************************************
            *           Press <ENTER> to continue           *
            *************************************************



end
goto -top


-on.error-
 if %R > 82 if %R < 90 type !! Floating Point Error !! |goto -Calc.
 Cls beep type Unexpected batch file error %R in line %L |exit
```

APPENDIX D. STATUS.DRS

```
;
;
report
time=maxtime,
FORMAT="5<"
">>>>>>>>>>>>>>>>>>>>>>>> PROJECT STATUS REPORT
<<<<<<<<<<<<<<<<<<<<<<<<<<";
;
Format="30<,40<,47<",PICTURE="Z,ZZ9V"
"AT TIME =",TM,"DAYS";;
Format="5<"
"INITIAL ESTIMATES:  (These will not change throughout the project)";
FORMAT="8<,54<,66<",PICTURE="ZZZ,ZZZV"
"System Size",IPRJSZ,"DSI";
FORMAT="8<,54<,66<",PICTURE="ZZZ,ZZZV"
"Programming Cost",TOTMDO,"Person Days";
FORMAT="8<,54<,66<",PICTURE="ZZZ,ZZZV"
"Programming Phase Duration (start-end)",TDEV,"Days";
;
Format="5<"
"UPDATED ESTIMATES";
FORMAT="8<,54<,66<",PICTURE="ZZZ,ZZ9V"
"Your Last Est of Programming Phase Cost",JBSZMD,"Person Days";
FORMAT="8<,54<,66<",PICTURE="ZZZ,ZZ9V"
"Your Last Est of Prog Phase Duration (start-end)",SCHCDT,"Days";
FORMAT="8<,54<,66<",PICTURE="ZZZ,ZZ9V"
"Time Remaining",TIMERM,"Days";
;
Format="5<"
"REPORTED PROGRESS";
FORMAT="8<,54<,66<",PICTURE="ZZZ,ZZ9V.99"
"% DSI Reported Complete",PRCMPL,"Percent";
FORMAT="8<,54<,66<",PICTURE="ZZZ,ZZ9V"
"Total DSI Reported Complete to Date",CMDSI,"DSI";
FORMAT="8<,54<,66<",PICTURE="ZZZ,ZZ9V"
"Total Person Days Expended to Date",CUMMD,"Person Days";
FORMAT="8<,54<,66<",PICTURE="ZZZ,ZZ9V"
"Reported Productivity",RPPROD,"DSI/Person Day";
;
FORMAT="5<"
"PRESS <ENTER> TO RETURN TO THE MENU"
```

APPENDIX E. STAFFING.DRS

```
;
;
report
time=maxtime,
FORMAT="5<"
">>>>>>>>>>>>>>>>>>>>>>>>>>>>> STAFFING REPORT
<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<";
;
Format="30<,40<,47<",PICTURE="Z,ZZ9V"
"AT TIME =",TM,"DAYS";
;
FORMAT="8<,54<,66<",PICTURE="ZZZ,ZZZV.9"
"Current Total Staff Size",FTEQWF,"People";
FORMAT="11<,54<,66<",PICTURE="ZZZ,ZZZV.9"
"Staff Allocated to Programming",CRDVWF,"People";
FORMAT="11<,54<,66<",PICTURE="ZZZ,ZZZV.9"
"Staff Allocated to QA",CRQAWF,"People";;
FORMAT="8<,54<,66<",PICTURE="ZZ,ZZZ9V"
"Percent of Workforce that is Experienced",FRWFEX*100,"Percent";
;
;
;
FORMAT="5<"
"PRESS <ENTER> TO RETURN TO THE MENU";
```

APPENDIX F. DEF.DRS

```
;
;
report
time=maxtime,
FORMAT="5<"
">>>>>>>>>>>>>>>>>>>>>>>>>>>> DEFECT REPORT
<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<";
;
FORMAT="1<,69<,72<",PICTURE="ZZ9V"
"-----CUMULATIVE STATUS FROM START OF PROGRAMMING TO CURRENT DAY
=>",TM,"---------";
FORMAT="8<,54<,66<",PICTURE="ZZZ,ZZ9V"
"TOTAL Defects Detected",CMERD,"Defects";
FORMAT="8<,54<,66<",PICTURE="ZZZ,ZZ9V.99"
"TOTAL KDSI Completed",CMDSI/1000,"KDSI";
FORMAT="8<,54<,66<",PICTURE="ZZZ,ZZ9V.9"
"Defect Density",CMERD*1000/CMDSI,"Defects/KDSI";
;
FORMAT="8<,54<,66<",PICTURE="ZZZ,ZZZV"
"QA Person Days Expended to Date",CMQAMD,"Person Days";
FORMAT="8<,54<,66<",PICTURE="ZZZ,ZZZV"
"Programming Person Days Expended to Date",CUMMD-CMQAMD,"Person Days";
FORMAT="11<,54<,66<",PICTURE="ZZZ,ZZZV"
"TOTAL Person Days Expended to Date",CUMMD,"Person Days";
;
FORMAT="1<"
"------------------STATISTICS FOR THE LAST 40 DAY PERIOD
ONLY--------------------";
FORMAT="8<,54<,66<",PICTURE="ZZZ,ZZZV"
"QA Person Days Expended Last 40 Days",PRQAMD,"Days";
FORMAT="8<,54<,66<",PICTURE="ZZZ,ZZ9V"
"Defects Detected Last 40 Days",PRERD,"Defects";
FORMAT="8<,54<,66<",PICTURE="ZZZ,ZZ9V.9"
"Defect Density Observed Last 40 Days",PRDFDS,"Defects/KDSI";
;
;
FORMAT="5<"
"PRESS <ENTER> TO RETURN TO THE MENU";
```

APPENDIX G. *PLOT.DRS FILES

STATPLOT.DRS:

```
plotxy <TM"TIME (DAYS) ",0,480>,
<SCHCDT"EST PROGRAMMING PHASE DURATION (START-END) ",0,440>,
<JBSZMD"EST PROGRAMMING COST (PERSON DAYS) ",0,4000>
```

STAFPLOT.DRS:

```
plotxy <TM"TIME (DAYS) ",0,480>,<FTEQWF"TOTAL STAFF (PERSONS) ",0,24>,
  <CRQAWF"QA STAFF (PERSONS) ",0,24>,<CRDVWF"PROG STAFF (PERSONS)
",0,24>
```

DEFPLOT.DRS:

```
plotxy <TM"TIME (DAYS) ",0,600>,<PRQAMD"QA PERSON DAYS PER PERIOD
",0,240>,<PRERD"DEFECTS DETECTED PER PERIOD ",0,240>
```

FEEDPLOT.DRS:

```
plotxy <TM"TIME (DAYS) ",0,480>,
<PLAN " PLANNED % COMPLETION RATE",0,100>,
<REPRT" % DSI REPORTED COMPLETED ",0,100>
```

APPENDIX H: START/FINISH.BAT

```
start.bat
cls
@echo off
@echo.
@echo.
@echo                           Starting the Project Simulation.
@echo.
@echo  Copying files...
@echo.
mkdir c:\proja21
copy *.* c:\proja21
c:
cd c:\proja21
cls
proja
```

```
finish.bat
echo off
cls
copy *.* b:
```

APPENDIX I. A11 INSTRUCTION SET

Your Name: ______________________ A11
SMC No.: ______________________

1. Introduction

The exercise you are about to undertake is similar in many ways to flight simulators that pilots use to mimic flying an aircraft from takeoff at point A to landing at point B. Instead of flying an aircraft, though, the simulator mimics the programming phase of a real software project. In this simulation, you will be more than an observer. In fact, you will play the role of manager of the programming phase of the project. Specifically, your role will be to track the progress of the project by reviewing status reports and graphs available every two-month interval (40 working days) during the programming phase. As the manager, you must then make two staffing decisions. First, the total number of staff you need. (You can hire additional staff, or decrease the staffing level as you deem necessary to complete your programming task successfully.) Second, you need to decide on what percent of your total staff to allocate to the Quality Assurance activity to be conducted throughout the programming phase (e.g. to do inspections).

2. Project

The project that you will manage happens to have been a real project conducted in a real organization. For the project, you will be given a project profile containing the following initial information:

Estimated Size of the System:	in Delivered Source Instructions (DSI)
Estimated Cost of Programming Phase:	in Number of Person Days
Estimated Duration of Programming Phase:	in Number of Work Days
Size of initial Core Team:	in People

The Core Team is a skeleton staff of software professionals who are there to ensure continuity between the requirements/design phase (which you may assume has just been completed), and the programming phase you are to manage.

The cost and schedule estimates are derived from a new off-the-shelf estimation tool, call it "NEW_TOOL", that has been recently acquired.

Historically, the defect density (i.e. number of defects detected during programming divided by the number of KDSI developed) has ranged from 5 - 20 Defects/KDSI.

3. Your task

Your task at every 40-day interval is to review the project's status, and make any necessary adjustments to the staffing level and its allocation. In order to do so, you may feel that is necessary to first adjust the project's cost and duration targets. The staffing decision should be done as follows:

1. Decide on the total staffing level, and

2. Decide on what percentage of the staff should be allocated to the quality assurance function (i.e. a number between 0 and 100).

4. Your Goal for the Task:

Minimize total cost incurred and minimize schedule overrun.

Your grade for the simulation will be based on an equal weighing of these two factors.

5. Some Important Points to Consider in Managing Your Task

1. As the manager of the programming phase, you specify the desired staffing level. You may find that your actual staffing level (as it will appear in the reports) is different from what you requested. This would be due to factors you cannot control, such as hiring delays and turnover.

2. The staff size you select may have fractions (e.g. 4.5 people).

3. When requesting additional staff, expect a delay in hiring. For modest additions to your staffing, the average hiring delay will be around 40 days. However, if you request a large number of additional staff, the average hiring delay will be much longer.

4. Once new people are hired, they must be trained and assimilated. The assimilation/training period is typically 80 days. During this assimilation/training period you can expect the new employee to be only half as productive as an experienced employee.

5. Adding more people increases communication and coordination overhead as happens in reality.

6. Rules of the Game

1. You must work alone. At no time are you to discuss the progress of the project with anyone.

2. If you have a question, ask the lab attendant.

3 You are not allowed to bring any notes or other "gouge" to use during the simulation. Feel free to write on the documentation sheets provided.

4. A calculator is allowed and recommended.

7. Instructions for Starting the System

Follow the instructions Carefully. If any problems arise, **immediately** seek out the lab attendant.

1. Insert the disk into the B: drive. Do not remove the disk from the drive!

2. From the C:\ prompt, type B: Do NOT start the network!

3. Start the simulation by typing START at the B:\ prompt.

4. Follow the instructions as they appear on the screen.

5. The simulation is complete when the **% Programming Reported Complete** in the PROJECT STATUS REPORT is 100%. When this occurs **Call the lab attendant.**

Your Name: ______________________
SMC No.: ______________________

YOUR GOAL IS:

Minimize total cost incurred and minimize schedule overrun.

INITIAL ESTIMATES:

Project Size	24400 DSI
Project Cost	944 Person Days
Project Duration (start-end)	272 Days

TIME ELAPSED (DAYS)	ESTIMATED PRODUCTI-VITY (DSI/P-D)	ESTIMATED COST (PERS-DAYS)	ESTIMATED DURATION (DAYS)	STAFFING LEVEL (PERSONS)	QUALITY ASSURANCE (PERCENT)
Initial Decision		944	272		
Time Elapsed - 40 Days					
Time Elapsed - 80 Days					
Time Elapsed - 120 Days					
Time Elapsed - 160 Days					
Time Elapsed - 200 Days					
Time Elapsed - 240 Days					
Time Elapsed - 280 Days					
Time Elapsed - 320 Days					
Time Elapsed - 360 Days					
Time Elapsed - 400 Days					
Time Elapsed - 440 Days					
Time Elapsed - 480 Days					
Time Elapsed - 520 Days					

****** WHEN YOU ARE DONE, CALL THE LAB ATTENDANT ******

APPENDIX J: B11 INSTRUCTION SET

Your Name: ______________________ B11
SMC No.: ______________________

1. Introduction

The exercise you are about to undertake is similar in many ways to flight simulators that pilots use to mimic flying an aircraft from takeoff at point A to landing at point B. Instead of flying an aircraft, though, the simulator mimics the programming phase of a real software project. In this simulation, you will be more than an observer. In fact, you will play the role of manager of the programming phase of the project. Specifically, your role will be to track the progress of the project by reviewing status reports and graphs available every two-month interval (40 working days) during the programming phase. As the manager, you must then make two staffing decisions. First, the total number of staff you need. (You can hire additional staff, or decrease the staffing level as you deem necessary to complete your programming task successfully.) Second, you need to decide on what percent of your total staff to allocate to the Quality Assurance activity to be conducted throughout the programming phase (e.g. to do inspections).

2. Project

The project that you will manage happens to have been a real project conducted in a real organization. For the project, you will be given a project profile containing the following initial information:

Estimated Size of the System:	in Delivered Source Instructions (DSI)
Estimated Cost of Programming Phase:	in Number of Person Days
Estimated Duration of Programming Phase:	in Number of Work Days
Size of initial Core Team:	in People

The Core Team is a skeleton staff of software professionals who are there to ensure continuity between the requirements/design phase (which you may assume has just been completed), and the programming phase you are to manage.

The cost and schedule estimates are derived from a new off-the-shelf estimation tool, call it "NEW_TOOL", that has been recently acquired.

Historically, the defect density (i.e. number of defects detected during programming divided by the number of KDSI developed) has ranged from 5 - 20 Defects/KDSI.

3. Your task

Your task at every 40-day interval is to review the project's status, and make any necessary adjustments to the staffing level and its allocation. In order to do so, you may feel that is necessary to first adjust the project's cost and duration targets. The staffing decision should be done as follows:

1. Decide on the total staffing level, and

2. Decide on what percentage of the staff should be allocated to the quality assurance function (i.e. a number between 0 and 100).

4. Your Goal for the Task:

Minimize total cost incurred and minimize schedule overrun.

Your grade for the simulation will be based on an equal weighing of these two factors.

5. Some Important Points to Consider in Managing Your Task

1. As the manager of the programming phase, you specify the desired staffing level. You may find that your <u>actual</u> staffing level (as it will appear in the reports) is different from what you requested. This would be due to factors you cannot control, such as hiring delays and turnover.

2. The staff size you select may have fractions (e.g. 4.5 people).

3. **When requesting additional staff, expect a delay in hiring.** For modest additions to your staffing, the average hiring delay will be around 40 days. However, if you request a large number of additional staff, the average hiring delay will be much longer.

4. Once new people are hired, they must be trained and assimilated. The assimilation/training period is typically 80 days. During this assimilation/training period you can expect the new employee to be only half as productive as an experienced employee.

5. Adding more people increases communication and coordination overhead as happens in reality.

6. Rules of the Game

1. You must work alone. At no time are you to discuss the progress of the project with anyone.

2. If you have a question, ask the lab attendant.

3 You are not allowed to bring any notes or other "gouge" to use during the simulation. Feel free to write on the documentation sheets provided.

4. A calculator is allowed and recommended.

7. Instructions for Starting the System

<u>Follow the instructions Carefully</u>. If any problems arise, **immediately** seek out the lab attendant.

1. Insert the disk into the B: drive. Do not remove the disk from the drive!

2. From the C:\ prompt, type B: Do NOT start the network!

3. Start the simulation by typing START at the B:\ prompt.

4. Follow the instructions as they appear on the screen.

5. The simulation is complete when the **% Programming Reported Complete** in the PROJECT STATUS REPORT is 100%. When this occurs **<u>Call the lab attendant</u>.**

Your Name: ____________________
SMC No.: ____________________

YOUR GOAL IS:

Minimize total cost incurred and minimize schedule overrun.

INITIAL ESTIMATES:

Project Size	24400 DSI
Project Cost	944 Person Days
Project Duration (start-end)	272 Days

TIME ELAPSED (DAYS)	ESTIMATED PRODUCTI-VITY (DSI/P-D)	ESTIMATED COST (PERS-DAYS)	ESTIMATED DURATION (DAYS)	STAFFING LEVEL (PERSONS)	QUALITY ASSURANCE (PERCENT)
Initial Decision		944	272		
Time Elapsed - 40 Days					
Time Elapsed - 80 Days					
Time Elapsed - 120 Days					
Time Elapsed - 160 Days					
Time Elapsed - 200 Days					
Time Elapsed - 240 Days					
Time Elapsed - 280 Days					
Time Elapsed - 320 Days					
Time Elapsed - 360 Days					
Time Elapsed - 400 Days					
Time Elapsed - 440 Days					
Time Elapsed - 480 Days					
Time Elapsed - 520 Days					

****** WHEN YOU ARE DONE, CALL THE LAB ATTENDANT ******

APPENDIX K: DESCRIPTION OF THE SIMULATION INTERFACE
REPORTS AND GRAPHS MENU:

After every 40-day simulation period, you will immediately get the Reports and Graphs Menu shown below. All of the reports and graphs concerning your project's progress are available from this menu. You may select any of them by pressing their corresponding number.

```
                         REPORTS AND GRAPHS MENU

REPORTS:
                1     PROJECT STATUS REPORT
                2     STAFFING REPORT
                3     DEFECT REPORT
                4     CUMULATIVE REPORT
GRAPHS:
                5     PROJECT PROGRESS GRAPH
                6     STAFFING GRAPH
                7     COST AND DURATION GRAPH
                8     DEFECT STATUS GRAPH
     PRESS      P     TO PROCEED TO ENTER DECISIONS FOR THE NEXT 40 DAYS
     Choose an option: (Do NOT hit <ENTER> after selection!!!);
```

After viewing the pertinent information (you may view any report or graph more than once), use the "P" selection to proceed to enter your decisions for the next 40 day simulation period.

Report 1 (PROJECT STATUS REPORT)   A sample report is pictured below:

```
>>>>>>>>>>>>>>>>>>>>>>>>> PROJECT STATUS REPORT <<<<<<<<<<<<<<<<<<<<<<<<<
                          AT TIME =   120  DAYS

INITIAL ESTIMATES:  (These will not change throughout the project)
   System Size                                         20,000    DSI
   Programming Cost                                     1,400    Person Days
   Programming Phase Duration (start-end)                 350    Days

UPDATED ESTIMATES
   Your Last Est of Programming Phase Cost              1,500    Person Days
   Your Last Est of Prog Phase Duration (start-end)       330    Days
   Time Remaining                                         210    Days

REPORTED PROGRESS
   % DSI Reported Complete                              36.04    Percent
   Total DSI Reported Complete to Date                  7,207    DSI
   Total Person Days Expended to Date                     503    Person Days
   Reported Productivity                                   14    DSI/Person Day

PRESS <ENTER> TO RETURN TO THE MENU
```

This report contains Project Status information as of a particular day in the programming phase. The report is divided into 3 sections. The top section shows the INITIAL ESTIMATES provided to your customer. This information will not change throughout the project.

The middle portion is the UPDATED ESTIMATES section. The entries of Your Last Est of Programming Phase Cost and Your Last Est of Prog Phase Duration (start-end) would reflect any change in cost and duration that you feel you need to make. The Time Remaining is equal to your current estimate of total duration minus current time.

The bottom section is the REPORTED PROGRESS section. Remember that this is "reported" information and is not guaranteed to be totally accurate, especially early in the phase. Reported Productivity is simply calculated as Total DSI Reported Complete to Date divided by Total Person Days Expended to Date.

Your Task is complete when the % DSI Reported Complete is 100%.

Report 2 (STAFFING LEVEL REPORT)   A sample report is pictured below:

```
>>>>>>>>>>>>>>>>>>>>>>>>>>>>> STAFFING REPORT <<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
                          AT TIME =    80  DAYS

    Current Total Staff Size                                6.1    People
       Staff Allocated to Programming                       5.5    People
       Staff Allocated to QA                                 .6    People

    Percent of Workforce that is Experienced               59      Percent


PRESS <ENTER> TO RETURN TO THE MENU
```

This report contains staffing information as of a particular day in the programming phase. The Current Total Staff Size consists of your total staff allocated to both programming activities and QA activities. It is the sum of Staff Allocated to Programming and Staff Allocated to QA.

The Percent of Workforce that is Experienced is also shown on this report. This is the number of experienced people (i.e. already trained/assimilated) divided by the total staff size (which is the sum of experienced and new staff). Once new people are hired, they go through an assimilation/training period. This is the time needed to train a new employee in the mechanics of the project and bring him/her up to speed. A new employee (i.e. one that is being trained) is only half as productive as an experienced employee.

Report 3 (DEFECT REPORT)   A sample report is pictured below:

```
>>>>>>>>>>>>>>>>>>>>>>>>>> DEFECT REPORT <<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
-----CUMULATIVE STATUS FROM START OF PROGRAMMING TO CURRENT DAY => 120---------
       TOTAL Defects Detected                             59      Defects
       TOTAL KDSI Completed                                5.83   KDSI
       Defect Density                                     10.1    Defects/KDSI

       QA Person Days Expended to Date                    39      Person Days
       Programming Person Days Expended to Date          353      Person Days
          TOTAL Person Days Expended to Date             393      Person Days
------------------STATISTICS FOR THE LAST 40 DAY PERIOD ONLY--------------------

       QA Person Days Expended Last 40 Days               15      Days
       Defects Detected Last 40 Days                      22      Defects
       Defect Density Observed Last 40 Days               10.3    Defects/KDSI

    PRESS <ENTER> TO RETURN TO THE MENU
```

This report recaps the TOTAL Person Days Expended to Date and provides a breakdown of the number of person days expended on both the QA and programming activities.

In the top section, this report gives cumulative defect data (i.e. from start of programming phase to current time). The bottom section shows data for the last 40 day period only.

Historically, the Defect Density (i.e. number of defects detected during programming divided by the number of KDSI developed) has ranged from 5-20 Defects/KDSI.

Comparing the aggregate data and the data for the last period can indicate trends.

Report 4 (CUMULATIVE REPORT)   A sample report is pictured below:

```
>>>>>>>>>>>>>>>>>>> PROJECT CUMULATIUE REPORT <<<<<<<<<<<<<<<<<<<<<<<<<<

UPDATED ESTIMATES                              REPORTED PROGRESS

TIME     COST    DURATION                      %DSI-COMP  PD-EXPENDED    PROD
 40     1,400     350                              8          93          17
 80     1,400     350                             16         200          16
120     1,500     350                             25         312          16

PRESS <ENTER> TO RETURN TO THE MENU
```

This report contains Cumulative Project Status information from the start of the project to the current period. The report is divided into 2 sections.

The left portion is the UPDATED ESTIMATES section. It reflects cumulative changes in the following project estimates:

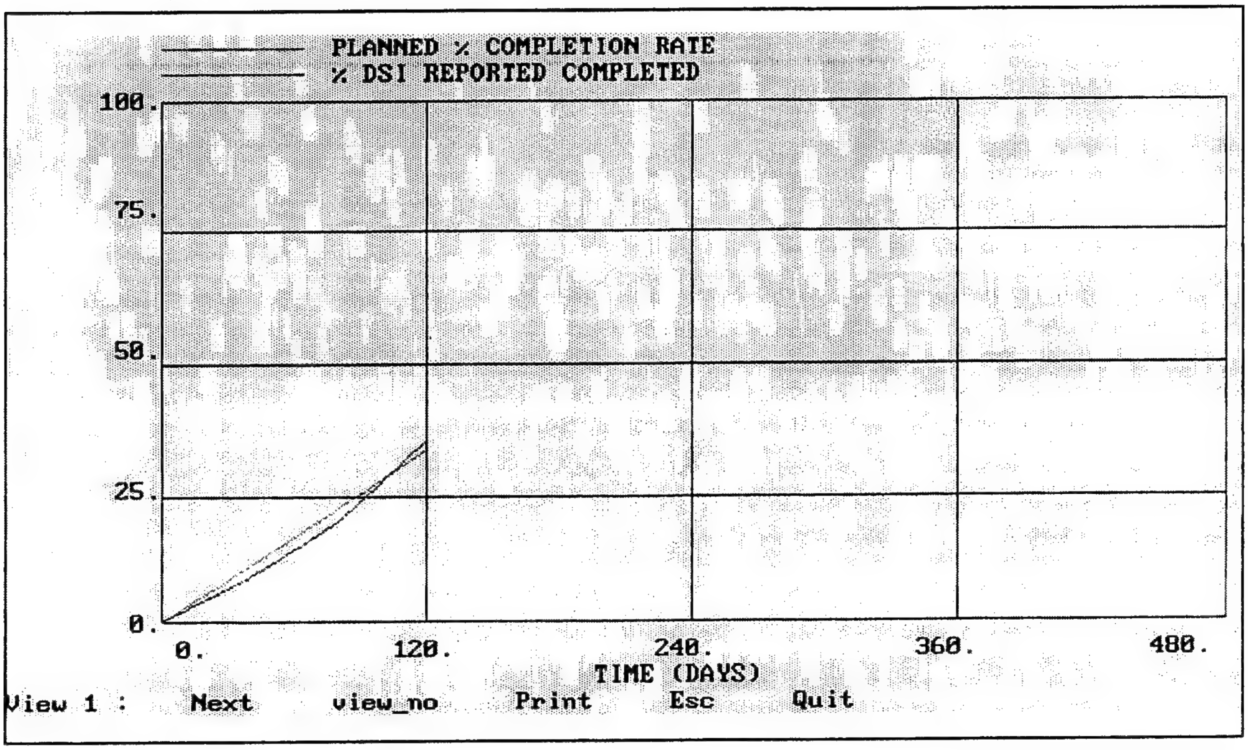
COST	Your Estimate of Programming Phase Cost (Person Days)
DURATION	Your Estimate of Prog Phase Duration (start-end) (Days)

The right portion is the REPORTED PROGRESS section. Remember that this is "reported" information and is not guaranteed to be totally accurate, especially early in the phase. It reflects cumulative changes in the following project estimates:

%DSI-COMP	%DSI Reported Complete (Percent)
PD EXPENDED	Total Person Days Expended to Date (Person Days)
PROD	Reported Productivity (DSI/Person Day)

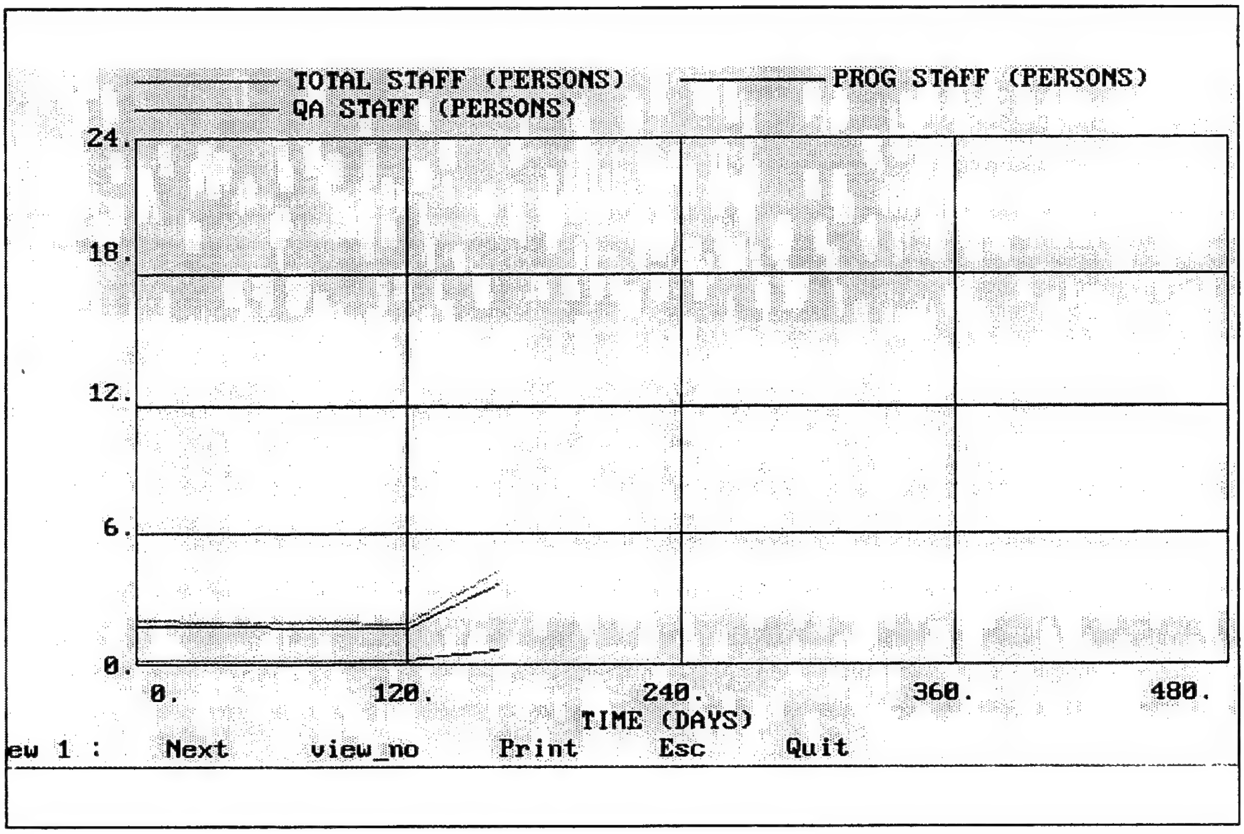
Your Task is complete when the % DSI is 100%.

Graph 5 (PROJECT PROGRESS GRAPH)



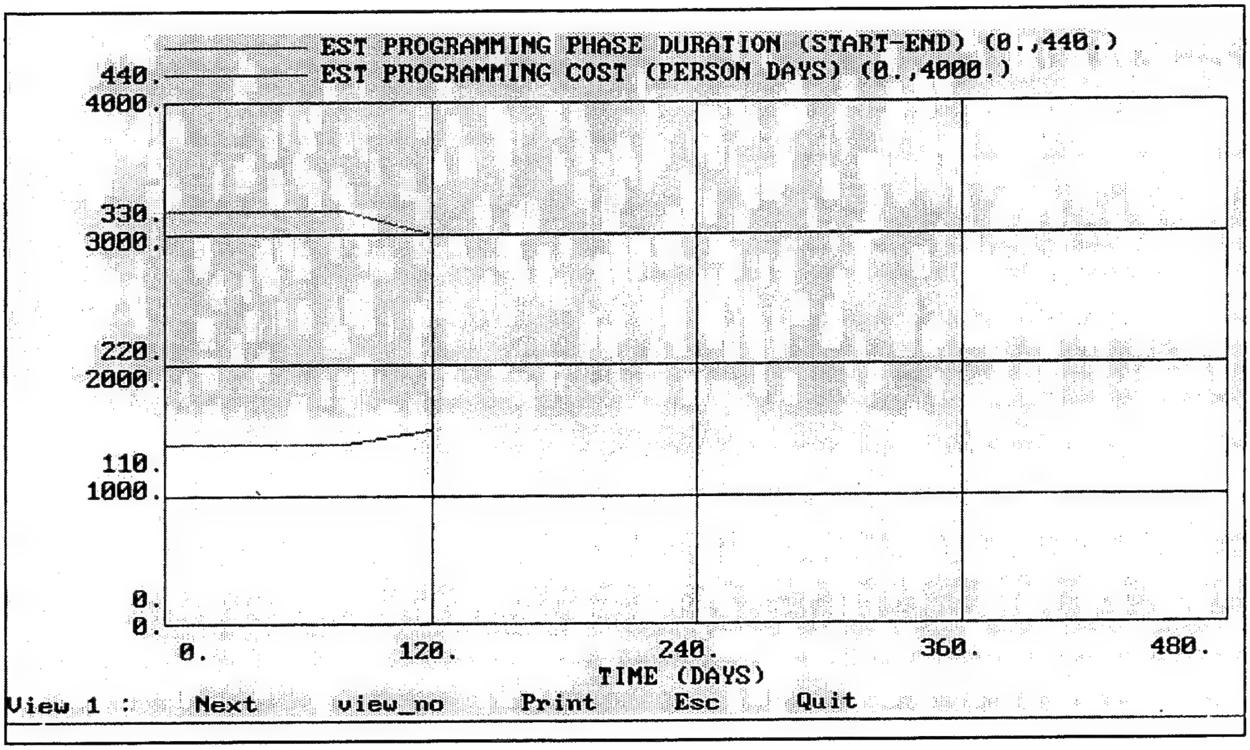
This graph compares the level of "planned % completion rate" and "%DSI reported complete" over time.

Graph 6 (STAFFING GRAPH)



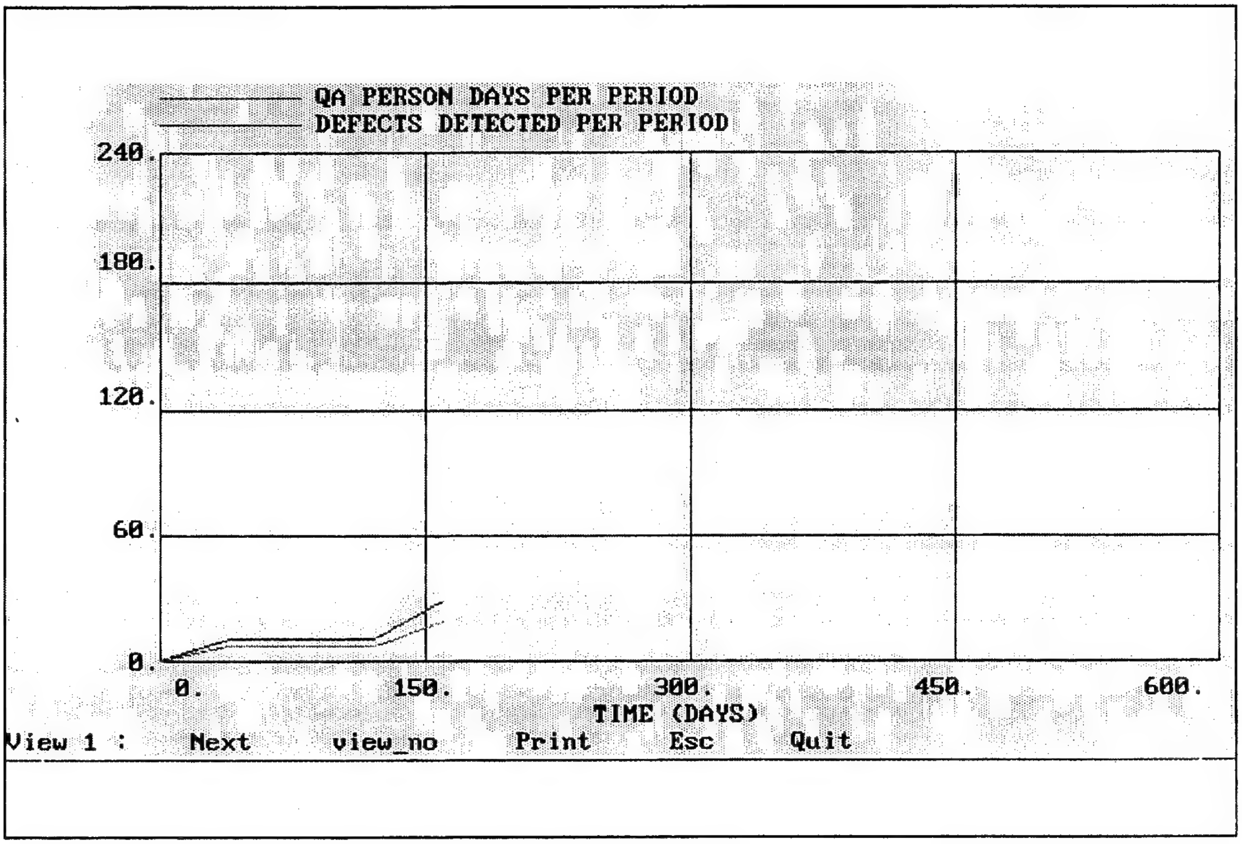
This graph shows how the level of the total staff, programming staff, and QA staff is changing over time.

Graph 7 (PROJECT COST AND DURATION GRAPH)



This graph shows how the estimates of programming phase duration and programming cost are changing over time.

Graph 8 (DEFECT GRAPH)



This graph shows how "QA person days expended per period" and the "number of defects detected per period" are changing over time.

APPENDIX L. MASTER PROJECT QUESTIONNAIRE

PROJECT QUESTIONNAIRE XXX

Your Name: ______________________________
SMC No.: ______________________________

1. In making your decisions, how much weight out of 100 points did you accord to the following goals? (The numbers should total 100 points.)

Cost [or QUALITY] ___

Schedule ___
100

2. Describe (in words, numbers, equation, etc.) what decision rule you followed in deciding on the overall staffing level in this project:

____

____

____

____

3. Describe (in words, numbers, equation, etc.) how you allocated staff between programming and quality assurance.

____

____

____

____

4. **Please try to elaborate on the thinking process you went through in making your decisions in this project (use back of page if necessary):**

____

____

____

5. **How clear were the instructions regarding the task?**

1	2	3	4	5	6	7	8	9
Not at all Clear								Very Clear

6. **To what extent was the graphical information provided on the progress of the project helpful in improving your own decisions?**

1	2	3	4	5	6	7	8	9
Not at all Helpful								Very Helpful

7. **To what extent were the reports on the progress of the project helpful in improving your own decisions?**

1	2	3	4	5	6	7	8	9
Not at all Helpful								Very Helpful

8. **In the project that you just completed, did you**

   (a) **Use the PROJECT STATUS report (Y/N)?** ________

   (b) **If you did, please describe how you used the information.**

____

____

____

9. In the project that you just completed, did you

(a) Use the STAFFING LEVEL report (Y/N)? ________

(b) If you did, please describe how you used the information.

____

____

____

10. In the project that you just completed, did you

(a) Use the DEFECT report (Y/N)? ________

(b) If you did, please describe how you used the information.

____

____

____

11. In the project that you just completed, did you

(a) Use the PROJECT STATUS graph (Y/N)? ________

(b) If you did, please describe how you used the information.

____

____

____

12. **In the project that you just completed, did you**

(a) **Use the STAFFING LEVEL graph (Y/N)?** ________

(b) **If you did, please describe how you used the information.**

____

____

____

13. **In the project that you just completed, did you**

(a) **Use the DEFECT graph (Y/N)?** ________

(b) **If you did, please describe how you used the information.**

____

____

____

14. **Have you in the past participated in project management (Y/N)?** ___

If YES, to what extent was the task in this simulation similar to your previous experience?

1	2	3	4	5	6	7	8	9
Not at all Similar								**Very Similar**

15. **How interesting was the task you just performed?**

1	2	3	4	5	6	7	8	9
Not at all Interesting								**Very Interesting**

16. How serious were you in performing the task?

1 2 3	4	5	6	7	8	9			
Not at all Serious									Very Serious

17. How clear were the instructions regarding the task, generally?

1	2	3	4	5	6	7	8	9
Not at all Clear								Very Clear

18. How easy was the simulation to use?

1	2	3	4	5	6	7	8	9
Not at all Easy								Very Easy

19. Please give us some information about yourself.

(a) Curriculum enrolled in: ____________________

(b) Age ______

(c) Sex ______

(d) Full time work experience (in years) ______

(e) How long ago (in years) did you complete your undergraduate education? ______

(f) How familiar are you with computers, generally?

1	2	3	4	5	6	7	8	9
Not at all Familiar								Very Familiar

(g) How many hours (per week) do you use computers?

____

20. Your general comments regarding the simulation:

***** END OF SIMULATION *****
Thank you for your participation.

APPENDIX M: WINDOWS 95 INSTRUCTIONS

Since this simulation will be used in future experiments on computers running Windows 95, the simulation has been upgraded. To use the simulation in Windows 95, the following instructions are provided:

1. A new BAT.COM files has been provided which will work in Windows 95.

2. To operate the simulation in Windows 95, Push F8 when the "starting windows" dialogue appears, then select option 8.

3. Type "start"

APPENDIX N. SEATING CHARTS

Seating Chart
Monday Wednesday
27 and 29 Nov.

IN-224
1 - 3 PM

(Front)

Graves	King	Magno	Margraf	Stone	Marrow
Norris	Parker	Petitt	Sauer	Stoier	Mihalan
		Tiddy	West		

IN-250
12 - 2 PM

(Front)

Dennis	Kern	Kopper	Larkhorst	Leonard	Lucas	Mullis
Trovini	Sadoski	Shaffer	Smith	Sprague	Stueve	Tompkins
Ring	Turner	X				
	X	X	X	X		

Seating Chart
Tuesday Thursday
28 and 30 Nov.

IN-224
1 - 3 PM

(Front)

Asmus	Brady	Cameron	Casey	Celebi	Cepek
Chalfant	Cheney	Cooke	Earley	Flick	Gearhard
		Geberth			

IN-250
1 - 3 PM

(Front)

Gillum	Hague	Heaton	Hoing	Jacobson	James	Johnson
Jones	Romano	Waller	Coats			
		X				
	X	X	X	X		

APPENDIX O. KEY TO DATA FILE VARIABLES

Format explanation of PERFORM.DAT file:

One line containing 5 identifiers plus 10 variables captured at project completion:

Name	Subject's name
SMC	Student Mail Center Box Number
Project	A initially underestimated, B initially overestimated
Goal	1 = Cost and Schedule, 2 = Quality and Schedule
Order	The order that the goals were listed on the instructions (1 or 2)
FNCOST	Final Cost (in Man Days)
FNTIME	Final Cumulative Time (Days)
FNERR	Final Errors Remaining Undetected
FNERG	Final Cumulative Errors Generated
FNERD	Final Cumulative Errors Detected
FNERES	Final Cumulative Errors Excaping Detection
FNPRDT	Final Percentage of Errors Detected
FNQAMD	Final Cumulative Quality Assurance Man Days
FNTRMD	Final Cumulative Training Man Days
FNRWMD	Final Cumulative Rework Man Days

Format explanation of PROCESS.DAT

One line containing 6 identifiers, 26 output variables, then 5 decision variables captured at project start and every 40 workdays until project completion:

Name	Subject's name
SMC	Student Mail Center Box Number
Project	A increased in size, B decreased in Size
Goal	1 = Cost and Schedule, 2 = Quality and Schedule
Order	The order that the goals were listed on the instructions (1 or 2)
Day	The period that the decisions were made
IPRJSZ	Initial Project Size (in Delivered Source Instructions)
TOTMDO	Programming Phase Cost (in Man Days)
TDEV	Programming Phase Duration (Development Time in Days)
PJBSZT	Updated Est of System Size (in DSI)
FNERR	Final Errors Remaining Undetected
FNERG	Final Cumulative Errors Generated
TIMERM	Time Remaining
PRCMPL	Percent DSI Reported Complete
CMDSI	Total DSI Completed to Date
CUMMD	Total Person Days Expended to Date
RPPROD	Reported Productivity (in DSI/Person Day)
FTEQWF	Current Total Staff Size (in People)
CRDVWF	Staff Allocated to Programming (in People)
CRQAWF	Staff Allocated to QA (in People)
FRWFEX	Percent of Workforce that is Experienced
CMQAMD	QA Person Days Expended to Date
CMERD	Total Defects Detected
PRQAMD	QA Person Days Expended Last 40 Days
PRERD	Defects Detected Last 40 Days
PRDFDS	Defect Density Observed Last 40 Days
PRTKDV	DSI Developed Last 40 Days
TOTMD1	Programming Phase Cost (in Man Days)
WFS	Total Workforce Sought
CRRWWF	Current Rework Workforce (in People)
AFMDPJ	Actual Fraction of Man Days on Project
SCHPR	Schedule Pressure
PRODTY	Estimated programmer productivity
WFS2	Total Workforce Requested
FRMPQ1	Fraction of Workforce devoted to Quality Assurance (Percent)
JBSZMD	Last Est of Programming Phase Cost (in Person Days)
SCHCDT	Last Est of Prog Phase Duration (start-end in Days)

Format explanation of Questionnaire/Demographic Data:

Q1S	Question 1 Schedule Percent (All subjects)
Q1Q	Question 1 Quality Percent (value only for Goal 2)
Q1C	Question 1 Cost Percent (value only for Goal 1)
Q5	Question 5 Response (1-9)
Q6	Question 6 Response (1-9)
Q7	Question 7 Response (1-9)
Q8	Question 8 Response (0/1 1=Yes 0=No)
Q9	Question 9 Response (0/1 1=Yes 0=No))
Q10	Question 10 Response (0/1 1=Yes 0=No)
Q11	Question 11 Response (0/1 1=Yes 0=No)
Q12	Question 12 Response (0/1 1=Yes 0=No)
Q13	Question 13 Response (0/1 1=Yes 0=No)
Q14	Question 14 Response (0-9 0=No, 1-9 indicate yes and the value)
Q15	Question 15 Response (1-9)
Q16	Question 16 Response (1-9)
Q17	Question 17 Response (1-9)
Q18	Question 18 Response (1-9)
CURRIC	Curriculum number or abbreviation
AGE	Age (years)
SEX	M=Male, F=Female
WKEXP	Work Experience (Years)
EDAGO	Years since undergraduate education was completed
CFAM	Computer familiarity (1-9)
CHRSWK	Computer hours per week
GRADE	Numeric grade received in IS-4300 course

APPENDIX P PROCESS DATA

Repeated measures on process data.

09:37 Sunday, March 3, 1996

OBS	GOALS	PROJECT	LNAME	_NAME_	_0D00	_120D00	_160D00	_200D00	_240D00
1	1	A	Asmus	COST	944	950	950.0	950.0	950.0
2	1	A	Stueve	COST	944	1000	1000.0	1000.0	1300.0
3	1	A	gearhard	COST	944	944	1200.0	1200.0	1212.0
4	1	A	johnson	COST	944	1743	1743.0	1627.0	1627.0
5	1	A	jones	COST	944	1500	1500.0	1000.0	1000.0
6	1	A	leonard	COST	944	944	2200.0	2200.0	2200.0
7	1	A	norris	COST	944	1400	1400.0	1600.0	1850.0
8	1	A	stone	COST	944	944	1800.0	1800.0	1800.0
9	1	A	west	COST	944	944	944.0	1400.0	1400.0
10	1	B	CELEBI	COST	944	900	930.0	940.0	940.0
11	1	B	Cooke	COST	944	944	1000.0	1000.0	1000.0
12	1	B	Jacobson	COST	944	994	1340.6	1967.7	1930.0
13	1	B	brady	COST	944	1900	1900.0	620.0	.
14	1	B	casey	COST	944	944	944.0	1500.0	1400.0
15	1	B	flick	COST	944	834	794.0	754.0	714.0
16	1	B	gillum	COST	944	944	944.0	944.0	944.0
17	1	B	hague	COST	944	944	950.0	1400.0	1500.0
18	1	B	hsing	COST	944	900	920.0	940.0	944.0
19	1	B	romano	COST	944	944	944.0	944.0	1034.0
20	2	A	Dennis	COST	944	1267	1267.0	2018.0	2018.0
21	2	A	Lankhors	COST	944	944	944.0	944.0	944.0
22	2	A	Shaffer	COST	944	1000	1400.0	1400.0	2068.0
23	2	A	TURNER	COST	944	2000	2000.0	2200.0	2300.0
24	2	A	king	COST	944	944	1000.0	1500.0	1500.0
25	2	A	kopper	COST	944	980	1000.0	1000.0	1200.0
26	2	A	mihlon	COST	944	944	1000.0	1250.0	1300.0
27	2	A	ring	COST	944	1904	1904.0	2176.0	2720.0
28	2	A	staier	COST	944	2200	2200.0	2200.0	2200.0
29	2	B	Cameron	COST	944	1050	1150.0	1848.0	1763.5
30	2	B	Cepek	COST	944	1060	1620.0	1620.0	1440.0
31	2	B	Chalfant	COST	944	1400	1626.0	2440.0	2033.0
32	2	B	Chaney	COST	944	944	944.0	1570.0	2000.0
33	2	B	Earley	COST	944	1000	1632.0	1632.0	1800.0
34	2	B	Geberth	COST	944	938	942.0	950.0	948.0
35	2	B	Heaton	COST	944	2000	2200.0	3200.0	3200.0
36	2	B	James	COST	944	944	944.0	1000.0	2000.0
37	2	B	coats	COST	944	1040	1420.0	2204.0	2077.0
38	2	B	waller	COST	944	944	944.0	944.0	1300.0

OBS	_280D00	_320D00	_360D00	_40D00	_80D00	_400D00	_440D00	_480D00
1	950	950	950	944	944	.	.	.
2	.	.	.	1000	1000	.	.	.
3	.	.	.	944	944	.	.	.
4	1525	.	.	1627	1743	.	.	.
5	2000	.	.	2312	2000	.	.	.
6	2200	2200	2040	944	944	.	.	.
7	.	.	.	1400	1400	.	.	.
8	1800	.	.	944	944	.	.	.
9	.	.	.	944	944	.	.	.
10	940	940	.	940	940	.	.	.
11	.	.	.	944	944	.	.	.
12	1872	1789	1700	968	984	.	.	.
13	.	.	.	1000	950	.	.	.
14	1400	.	.	944	944	.	.	.
15	674	.	.	944	874	.	.	.
16	.	.	.	944	944	.	.	.
17	1500	.	.	944	944	.	.	.
18	944	.	.	900	900	.	.	.
19	1400	1500	.	944	944	.	.	.
20	2018	.	.	1267	1267	.	.	.
21	944	944	944	944	944	.	.	.
22	.	.	.	944	1000	.	.	.
23	2300	2300	.	1200	1200	.	.	.
24	.	.	.	944	944	.	.	.
25	.	.	.	950	950	.	.	.
26	.	.	.	944	944	.	.	.
27	2720	2720	.	1150	1904	.	.	.
28	.	.	.	1888	2000	.	.	.
29	.	.	.	1054	1073	.	.	.
30	2218	2218	.	1017	1060	.	.	.
31	1931	.	.	944	1572	.	.	.
32	1950	.	.	944	944	.	.	.
33	2300	2300	2300	944	1000	.	.	.
34	1100	1300	.	940	940	.	.	.
35	3200	.	.	1632	2400	.	.	.
36	2000	3000	3000	944	944	3000	3000	3000
37	2018	1913	.	1016	1120	.	.	.
38	1400	2000	2300	944	944	.	.	.

General Linear Models Procedure
Class Level Information

Class	Levels	Values
GOALS	2	1 2
PROJECT	2	A B

Number of observations in data set = 38

General Linear Models Procedure
Repeated Measures Analysis of Variance
Repeated Measures Level Information

Dependent Variable	_0D00	_40D00	_80D00	_120D00	_160D00	_200D00
Level of PERIOD	1	2	3	4	5	6

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD Effect
H = Type III SS&CP Matrix for PERIOD E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.43330173	8.1087	5	31	0.0001
Pillai's Trace	0.56669827	8.1087	5	31	0.0001
Hotelling-Lawley Trace	1.30786062	8.1087	5	31	0.0001
Roy's Greatest Root	1.30786062	8.1087	5	31	0.0001

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD*GOALS Effect
H = Type III SS&CP Matrix for PERIOD*GOALS E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.78079533	1.7406	5	31	0.1547
Pillai's Trace	0.21920467	1.7406	5	31	0.1547

Hotelling-Lawley Trace	0.28074536	1.7406	5	31	0.1547
Roy's Greatest Root	0.28074536	1.7406	5	31	0.1547

Manova Test Criteria and Exact F Statistics for
the Hypothesis of no PERIOD*PROJECT Effect
H = Type III SS&CP Matrix for PERIOD*PROJECT   E = Error SS&CP Matrix

S=1   M=1.5   N=14.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.85616720	1.0416	5	31	0.4111
Pillai's Trace	0.14383280	1.0416	5	31	0.4111
Hotelling-Lawley Trace	0.16799616	1.0416	5	31	0.4111
Roy's Greatest Root	0.16799616	1.0416	5	31	0.4111

Repeated measures on process data. 10
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General Linear Models Procedure
Repeated Measures Analysis of Variance
Tests of Hypotheses for Between Subjects Effects

Source	DF	Type III SS	Mean Square	F Value	Pr > F
GOALS	1	1256636.72320175	1256636.72320175	2.70	0.1092
PROJECT	1	1098499.45669055	1098499.45669055	2.36	0.1333
Error	35	16277870.78734450	465082.02249556		

Repeated measures on process data. 11
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General Linear Models Procedure
Repeated Measures Analysis of Variance
Univariate Tests of Hypotheses for Within Subject Effects

Source: PERIOD

					Adj Pr > F	
DF	Type III SS	Mean Square	F Value	Pr > F	G - G	H - F
5	6366921.41853	1273384.28371	17.11	0.0001	0.0001	0.0001

Source: PERIOD*GOALS

					Adj Pr > F	
DF	Type III SS	Mean Square	F Value	Pr > F	G - G	H - F

5	1200514.33075	240102.86615	3.23	0.0082	0.0278	0.0214

Source: PERIOD*PROJECT

					Adj Pr > F	
DF	Type III SS	Mean Square	F Value	Pr > F	G - G	H - F
5	280382.78520	56076.55704	0.75	0.5845	0.5166	0.5344

Source: Error(PERIOD)

DF	Type III SS	Mean Square
175	13021182.31287	74406.75607

Greenhouse-Geisser Epsilon = 0.5704
Huynh-Feldt Epsilon = 0.6618

---------------------------------- GOALS=1 PROJECT=A ----------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
_0D00	9	944.0000000	0	944.0000000	944.0000000
_40D00	9	1228.78	476.8515958	944.0000000	2312.00
_80D00	9	1207.00	409.5863767	944.0000000	2000.00
_120D00	9	1152.11	310.0106629	944.0000000	1743.00
_160D00	9	1415.22	438.1779826	944.0000000	2200.00
_200D00	9	1419.67	425.8151007	950.0000000	2200.00

---------------------------------- GOALS=1 PROJECT=B ----------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
_0D00	10	944.0000000	0	944.0000000	944.0000000
_40D00	10	947.2000000	24.8587119	900.0000000	1000.00
_80D00	10	936.8000000	29.7575387	874.0000000	984.0000000
_120D00	10	1024.80	310.3978809	834.0000000	1900.00
_160D00	10	1066.66	324.4168793	794.0000000	1900.00
_200D00	10	1100.97	403.1655134	620.0000000	1967.70

---------------------------------- GOALS=2 PROJECT=A ----------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
_0D00	9	944.0000000	0	944.0000000	944.0000000
_40D00	9	1136.78	310.0410367	944.0000000	1888.00
_80D00	9	1239.22	422.1030022	944.0000000	2000.00
_120D00	9	1353.67	525.9030329	944.0000000	2200.00
_160D00	9	1412.78	494.7438170	944.0000000	2200.00
_200D00	9	1632.00	522.0296926	944.0000000	2200.00

---------------------------------- GOALS=2 PROJECT=B ----------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
_0D00	10	944.0000000	0	944.0000000	944.0000000
_40D00	10	1037.90	212.8643021	940.0000000	1632.00
_80D00	10	1199.70	462.4476066	940.0000000	2400.00
_120D00	10	1132.00	334.4501292	938.0000000	2000.00
_160D00	10	1342.20	428.9993007	942.0000000	2200.00
_200D00	10	1740.80	723.3282335	944.0000000	3200.00

OBS	GOALS	PROJECT	LNAME	_NAME_	_0D00	_120D00	_160D00	_200D00	_240D00
1	1	A	Asmus	DURATION	272	250.0	250.0	260.0	280.0
2	1	A	Stueve	DURATION	272	300.0	300.0	300.0	300.0
3	1	A	gearhard	DURATION	272	272.0	272.0	272.0	280.0
4	1	A	johnson	DURATION	272	349.0	349.0	271.0	271.0
5	1	A	jones	DURATION	272	272.0	272.0	272.0	300.0
6	1	A	leonard	DURATION	272	272.0	272.0	272.0	302.0
7	1	A	norris	DURATION	272	272.0	272.0	272.0	272.0
8	1	A	stone	DURATION	272	272.0	272.0	272.0	300.0
9	1	A	west	DURATION	272	272.0	272.0	272.0	272.0
10	1	B	CELEBI	DURATION	272	272.0	272.0	272.0	272.0
11	1	B	Cooke	DURATION	272	272.0	272.0	280.0	280.0
12	1	B	Jacobson	DURATION	272	261.6	343.7	491.9	378.4
13	1	B	brady	DURATION	272	250.0	300.0	300.0	.
14	1	B	casey	DURATION	272	250.0	272.0	360.0	320.0
15	1	B	flick	DURATION	272	152.0	112.0	72.0	32.0
16	1	B	gillum	DURATION	272	272.0	272.0	272.0	272.0
17	1	B	hague	DURATION	272	272.0	238.0	300.0	285.0
18	1	B	hsing	DURATION	272	270.0	272.0	276.0	276.0

19	1	B	romano	DURATION	272	272.0	272.0	272.0	272.0
20	2	A	Dennis	DURATION	272	272.0	272.0	272.0	272.0
21	2	A	Lankhors	DURATION	272	272.0	272.0	272.0	272.0
22	2	A	Shaffer	DURATION	272	300.0	400.0	400.0	272.0
23	2	A	TURNER	DURATION	272	272.0	272.0	400.0	400.0
24	2	A	king	DURATION	272	272.0	272.0	272.0	255.0
25	2	A	kopper	DURATION	272	272.0	280.0	280.0	280.0
26	2	A	mihlon	DURATION	272	272.0	272.0	272.0	272.0
27	2	A	ring	DURATION	272	272.0	272.0	272.0	280.0
28	2	A	staier	DURATION	272	280.0	272.0	272.0	260.0
29	2	B	Cameron	DURATION	272	272.0	272.0	314.0	315.0
30	2	B	Cepek	DURATION	272	271.0	406.0	280.0	280.0
31	2	B	Chalfant	DURATION	272	292.0	313.0	406.0	359.0
32	2	B	Chaney	DURATION	272	272.0	272.0	272.0	272.0
33	2	B	Earley	DURATION	272	272.0	272.0	272.0	300.0
34	2	B	Geberth	DURATION	272	268.0	270.0	278.0	275.0
35	2	B	Heaton	DURATION	272	300.0	320.0	320.0	320.0
36	2	B	James	DURATION	272	272.0	300.0	300.0	325.0
37	2	B	coats	DURATION	272	273.0	348.0	680.0	405.0
38	2	B	waller	DURATION	272	272.0	272.0	272.0	300.0

OBS	_280D00	_320D00	_360D00	_40D00	_80D00	_400D00	_440D00	_480D00
1	290.0	360	360	272.0	272.0	.	.	.
2	.	.	.	300.0	300.0	.	.	.
3	.	.	.	272.0	272.0	.	.	.
4	254.0	.	.	407.0	436.0	.	.	.
5	300.0	.	.	272.0	272.0	.	.	.
6	302.0	302	302	272.0	272.0	.	.	.
7	.	.	.	272.0	272.0	.	.	.
8	300.0	.	.	272.0	272.0	.	.	.
9	.	.	.	272.0	272.0	.	.	.
10	272.0	272	.	270.0	272.0	.	.	.
11	.	.	.	272.0	272.0	.	.	.
12	340.5	313	298	242.0	246.0	.	.	.
13	.	.	.	400.0	320.0	.	.	.
14	320.0	.	.	272.0	272.0	.	.	.
15	12.0	.	.	272.0	192.0	.	.	.
16	.	.	.	272.0	272.0	.	.	.
17	285.0	.	.	272.0	272.0	.	.	.
18	276.0	.	.	272.0	272.0	.	.	.
19	272.0	290	.	272.0	272.0	.	.	.
20	290.0	.	.	272.0	272.0	.	.	.
21	272.0	272	272	272.0	272.0	.	.	.
22	.	.	.	272.0	300.0	.	.	.
23	350.0	350	.	272.0	272.0	.	.	.

24	.	.	.	272.0	272.0	.	.	.
25	.	.	.	272.0	272.0	.	.	.
26	.	.	.	272.0	272.0	.	.	.
27	290.0	294	.	272.0	272.0	.	.	.
28	.	.	.	272.0	280.0	.	.	.
29	.	.	.	310.1	233.7	.	.	.
30	320.0	360	.	282.0	151.0	.	.	.
31	320.0	.	.	272.0	262.0	.	.	.
32	290.0	.	.	272.0	272.0	.	.	.
33	360.0	360	375	272.0	272.0	.	.	.
34	275.0	360	.	270.0	268.0	.	.	.
35	320.0	.	.	272.0	300.0	.	.	.
36	360.0	500	500	272.0	272.0	500	500	500
37	377.0	348	.	210.0	226.0	.	.	.
38	320.0	440	400	272.0	272.0	.	.	.

General Linear Models Procedure
Class Level Information

Class	Levels	Values
GOALS	2	1 2
PROJECT	2	A B

Number of observations in data set = 38

General Linear Models Procedure
Repeated Measures Analysis of Variance
Repeated Measures Level Information

Dependent Variable	_0D00	_40D00	_80D00	_120D00	_160D00	_200D00
Level of PERIOD	1	2	3	4	5	6

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD Effect

H = Type III SS&CP Matrix for PERIOD E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.74468985	2.1256	5	31	0.0886
Pillai's Trace	0.25531015	2.1256	5	31	0.0886
Hotelling-Lawley Trace	0.34284092	2.1256	5	31	0.0886
Roy's Greatest Root	0.34284092	2.1256	5	31	0.0886

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD*GOALS Effect

H = Type III SS&CP Matrix for PERIOD*GOALS E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.80359118	1.5154	5	31	0.2137
Pillai's Trace	0.19640882	1.5154	5	31	0.2137
Hotelling-Lawley Trace	0.24441385	1.5154	5	31	0.2137
Roy's Greatest Root	0.24441385	1.5154	5	31	0.2137

Manova Test Criteria and Exact F Statistics for
the Hypothesis of no PERIOD*PROJECT Effect
H = Type III SS&CP Matrix for PERIOD*PROJECT E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.79561946	1.5927	5	31	0.1914
Pillai's Trace	0.20438054	1.5927	5	31	0.1914
Hotelling-Lawley Trace	0.25688227	1.5927	5	31	0.1914
Roy's Greatest Root	0.25688227	1.5927	5	31	0.1914

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General Linear Models Procedure
Repeated Measures Analysis of Variance
Tests of Hypotheses for Between Subjects Effects

Source	DF	Type III SS	Mean Square	F Value	Pr > F
GOALS	1	3011.30684211	3011.30684211	0.74	0.3955

PROJECT	1	459.00394737	459.00394737	0.11	0.7390
Error	35	142429.73149123	4069.42089975		

General Linear Models Procedure
Repeated Measures Analysis of Variance
Univariate Tests of Hypotheses for Within Subject Effects

Source: PERIOD

					Adj Pr > F	
DF	Type III SS	Mean Square	F Value	Pr > F	G - G	H - F
5	24567.3865673	4913.4773135	2.81	0.0181	0.0766	0.0708

Source: PERIOD*GOALS

					Adj Pr > F	
DF	Type III SS	Mean Square	F Value	Pr > F	G - G	H - F
5	22529.6868421	4505.9373684	2.58	0.0281	0.0928	0.0870

Source: PERIOD*PROJECT

					Adj Pr > F	
DF	Type III SS	Mean Square	F Value	Pr > F	G - G	H - F
5	14332.2602515	2866.4520503	1.64	0.1519	0.2056	0.2033

Source: Error(PERIOD)

DF	Type III SS	Mean Square
175	305974.6190468	1748.4263946

Greenhouse-Geisser Epsilon = 0.3394
Huynh-Feldt Epsilon = 0.3753

---------------------------------- GOALS=1 PROJECT=A --------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
_0D00	9	272.0000000	0	272.0000000	272.0000000
_40D00	9	290.1111111	44.8007936	272.0000000	407.0000000

_80D00	9	293.3333333	54.2954878	272.0000000	436.0000000
_120D00	9	281.2222222	28.3539141	250.0000000	349.0000000
_160D00	9	281.2222222	28.3539141	250.0000000	349.0000000
_200D00	9	273.6666667	10.6301458	260.0000000	300.0000000

---------------------------------- GOALS=1 PROJECT=B ----------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
_0D00	10	272.0000000	0	272.0000000	272.0000000
_40D00	10	281.6000000	42.6437438	242.0000000	400.0000000
_80D00	10	266.2000000	31.6992814	192.0000000	320.0000000
_120D00	10	254.3600000	37.0711988	152.0000000	272.0000000
_160D00	10	262.5700000	59.4340353	112.0000000	343.7000000
_200D00	10	289.5900000	102.5529289	72.0000000	491.9000000

---------------------------------- GOALS=2 PROJECT=A ----------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
_0D00	9	272.0000000	0	272.0000000	272.0000000
_40D00	9	272.0000000	0	272.0000000	272.0000000
_80D00	9	276.0000000	9.3808315	272.0000000	300.0000000
_120D00	9	276.0000000	9.3808315	272.0000000	300.0000000
_160D00	9	287.1111111	42.4159299	272.0000000	400.0000000
_200D00	9	301.3333333	56.0000000	272.0000000	400.0000000

---------------------------------- GOALS=2 PROJECT=B ----------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
_0D00	10	272.0000000	0	272.0000000	272.0000000
_40D00	10	270.4100000	24.4366051	210.0000000	310.1000000
_80D00	10	252.8700000	41.4518744	151.0000000	300.0000000
_120D00	10	276.4000000	10.5851048	268.0000000	300.0000000
_160D00	10	304.5000000	44.6498725	270.0000000	406.0000000
_200D00	10	339.4000000	126.4666842	272.0000000	680.0000000

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OBS	GOALS	PROJECT	LNAME	_NAME_	_0D00	_120D00	_160D00	_200D00	_240D00
1	1	A	Asmus	PROD	0	18.00	20.00	20.00	20.00
2	1	A	Stueve	PROD	0	20.00	20.00	20.00	20.00
3	1	A	gearhard	PROD	0	18.35	19.30	20.40	20.60
4	1	A	johnson	PROD	0	14.00	14.00	15.00	15.00
5	1	A	jones	PROD	0	9.00	9.00	15.00	15.00
6	1	A	leonard	PROD	0	10.00	9.00	10.00	10.00
7	1	A	norris	PROD	0	15.00	18.00	15.00	15.00
8	1	A	stone	PROD	0	14.00	14.00	16.00	16.00
9	1	A	west	PROD	0	16.00	17.00	19.00	19.00
10	1	B	CELEBI	PROD	0	27.00	25.00	20.00	26.00
11	1	B	Cooke	PROD	0	28.00	28.00	28.00	28.00
12	1	B	Jacobson	PROD	0	24.50	18.20	12.40	12.64
13	1	B	brady	PROD	0	25.00	25.00	15.00	.
14	1	B	casey	PROD	0	26.50	5.50	20.00	20.00
15	1	B	flick	PROD	0	30.00	50.00	100.00	100.00
16	1	B	gillum	PROD	0	26.00	20.00	16.00	18.00
17	1	B	hague	PROD	0	26.00	19.00	16.00	16.00
18	1	B	hsing	PROD	0	28.00	28.00	20.00	20.00
19	1	B	romano	PROD	0	26.00	13.00	20.00	30.00
20	2	A	Dennis	PROD	0	13.00	13.00	12.00	13.00
21	2	A	Lankhors	PROD	0	12.00	12.00	14.00	16.00
22	2	A	Shaffer	PROD	0	12.00	12.00	15.00	26.00
23	2	A	TURNER	PROD	0	9.00	9.00	9.00	10.00
24	2	A	king	PROD	0	13.00	20.00	20.00	20.00
25	2	A	kopper	PROD	0	13.00	15.00	15.50	17.00
26	2	A	mihlon	PROD	0	20.00	20.00	20.00	20.00
27	2	A	ring	PROD	0	13.00	13.00	12.00	12.00
28	2	A	staier	PROD	0	8.94	11.71	13.89	15.17
29	2	B	Cameron	PROD	0	29.00	18.00	13.00	14.00
30	2	B	Cepek	PROD	0	23.00	23.00	23.00	9.00
31	2	B	Chalfant	PROD	0	15.00	15.00	10.00	12.00
32	2	B	Chaney	PROD	0	25.40	20.00	15.00	15.00
33	2	B	Earley	PROD	0	24.00	15.00	15.00	10.00
34	2	B	Geberth	PROD	0	27.00	24.00	12.00	13.00
35	2	B	Heaton	PROD	0	13.00	13.00	11.00	11.00
36	2	B	James	PROD	0	25.56	15.68	6.54	7.54
37	2	B	coats	PROD	0	22.00	17.00	11.00	12.00
38	2	B	waller	PROD	0	26.00	26.00	15.00	15.00

OBS	_280D00	_320D00	_360D00	_40D00	_80D00	_400D00	_440D00	_480D00
1	20.00	22.00	22.00	16.00	16.00	.	.	.
2	.	.	.	20.00	20.00	.	.	.

3	.	.	.	18.32	17.89	.	.	.
4	16.00	.	.	15.00	14.00	.	.	.
5	15.00	.	.	10.00	10.00	.	.	.
6	11.00	12.00	12.00	11.00	8.00	.	.	.
7	.	.	.	15.00	15.00	.	.	.
8	16.00	.	.	10.00	14.00	.	.	.
9	.	.	.	16.00	16.00	.	.	.
10	26.00	26.00	.	25.00	26.00	.	.	.
11	.	.	.	28.00	28.00	.	.	.
12	13.03	13.64	14.30	25.20	24.80	.	.	.
13	.	.	.	24.00	24.00	.	.	.
14	20.50	.	.	25.00	25.00	.	.	.
15	100.00	.	.	25.00	50.00	.	.	.
16	.	.	.	25.00	25.00	.	.	.
17	16.00	.	.	26.00	26.00	.	.	.
18	20.00	.	.	25.00	28.00	.	.	.
19	30.00	25.00	.	26.00	26.00	.	.	.
20	14.00	.	.	18.00	15.00	.	.	.
21	16.00	16.00	16.00	12.00	12.00	.	.	.
22	.	.	.	17.00	12.00	.	.	.
23	11.00	11.00	.	11.00	10.00	.	.	.
24	.	.	.	26.00	26.00	.	.	.
25	.	.	.	16.00	14.00	.	.	.
26	.	.	.	18.00	20.00	.	.	.
27	12.00	12.00	.	18.00	18.00	.	.	.
28	.	.	.	10.80	7.07	.	.	.
29	.	.	.	23.14	22.70	.	.	.
30	11.00	11.00	.	24.00	24.00	.	.	.
31	13.00	.	.	25.00	25.00	.	.	.
32	15.00	.	.	25.00	25.40	.	.	.
33	15.00	15.00	12.00	25.00	24.40	.	.	.
34	13.00	15.00	.	27.00	27.00	.	.	.
35	11.00	.	.	16.00	12.00	.	.	.
36	8.00	8.73	9.34	25.00	25.38	9.99	10.42	10.37
37	12.00	13.00	.	25.00	25.00	.	.	.
38	15.00	15.00	15.00	25.00	25.00	.	.	.

General Linear Models Procedure
Class Level Information

Class	Levels	Values
GOALS	2	1 2

PROJECT 2 A B

Number of observations in data set = 38

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General Linear Models Procedure
Repeated Measures Analysis of Variance
Repeated Measures Level Information

Dependent Variable	_0D00	_40D00	_80D00	_120D00	_160D00	_200D00
Level of PERIOD	1	2	3	4	5	6

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD Effect
H = Type III SS&CP Matrix for PERIOD E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.01900105	320.0978	5	31	0.0001
Pillai's Trace	0.98099895	320.0978	5	31	0.0001
Hotelling-Lawley Trace	51.62867719	320.0978	5	31	0.0001
Roy's Greatest Root	51.62867719	320.0978	5	31	0.0001

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD*GOALS Effect
H = Type III SS&CP Matrix for PERIOD*GOALS E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.73634416	2.2200	5	31	0.0773
Pillai's Trace	0.26365584	2.2200	5	31	0.0773
Hotelling-Lawley Trace	0.35806062	2.2200	5	31	0.0773
Roy's Greatest Root	0.35806062	2.2200	5	31	0.0773

Manova Test Criteria and Exact F Statistics for

the Hypothesis of no PERIOD*PROJECT Effect
H = Type III SS&CP Matrix for PERIOD*PROJECT E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.24104698	19.5211	5	31	0.0001
Pillai's Trace	0.75895302	19.5211	5	31	0.0001
Hotelling-Lawley Trace	3.14856880	19.5211	5	31	0.0001
Roy's Greatest Root	3.14856880	19.5211	5	31	0.0001

General Linear Models Procedure
Repeated Measures Analysis of Variance
Tests of Hypotheses for Between Subjects Effects

Source	DF	Type III SS	Mean Square	F Value	Pr > F
GOALS	1	433.12746711	433.12746711	3.31	0.0776
PROJECT	1	2780.84385965	2780.84385965	21.23	0.0001
Error	35	4585.27692456	131.00791213		

General Linear Models Procedure
Repeated Measures Analysis of Variance
Univariate Tests of Hypotheses for Within Subject Effects

Source: PERIOD

					Adj Pr > F	
DF	Type III SS	Mean Square	F Value	Pr > F	G - G	H - F
5	11710.55586480	2342.11117296	69.37	0.0001	0.0001	0.0001

Source: PERIOD*GOALS

					Adj Pr > F	
DF	Type III SS	Mean Square	F Value	Pr > F	G - G	H - F
5	428.81399342	85.76279868	2.54	0.0301	0.1046	0.1001

Source: PERIOD*PROJECT

Adj Pr > F

DF	Type III SS	Mean Square	F Value	Pr > F	G - G	H - F
5	913.25745427	182.65149085	5.41	0.0001	0.0142	0.0119

Source: Error(PERIOD)

DF	Type III SS	Mean Square
175	5908.81074047	33.76463280

Greenhouse-Geisser Epsilon = 0.2872
Huynh-Feldt Epsilon = 0.3133

------------------------------------ GOALS=1 PROJECT=A ------------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
_0D00	9	0	0	0	0
_40D00	9	14.5911111	3.5797641	10.0000000	20.0000000
_80D00	9	14.5433333	3.6992432	8.0000000	20.0000000
_120D00	9	14.9277778	3.6941771	9.0000000	20.0000000
_160D00	9	15.5888889	4.3641850	9.0000000	20.0000000
_200D00	9	16.7111111	3.4425443	10.0000000	20.4000000

------------------------------------ GOALS=1 PROJECT=B ------------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
_0D00	10	0	0	0	0
_40D00	10	25.4200000	1.0685400	24.0000000	28.0000000
_80D00	10	28.2800000	7.7420640	24.0000000	50.0000000
_120D00	10	26.7000000	1.6193277	24.5000000	30.0000000
_160D00	10	23.1700000	11.7426147	5.5000000	50.0000000
_200D00	10	26.7400000	26.0863608	12.4000000	100.0000000

------------------------------------ GOALS=2 PROJECT=A ------------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
_0D00	9	0	0	0	0

_40D00	9	16.3111111	4.7456413	10.8000000	26.0000000
_80D00	9	14.8966667	5.7204545	7.0700000	26.0000000
_120D00	9	12.6600000	3.2102025	8.9400000	20.0000000
_160D00	9	13.9677778	3.7622260	9.0000000	20.0000000
_200D00	9	14.5988889	3.6234322	9.0000000	20.0000000

---------------------------------- GOALS=2 PROJECT=B --------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
_0D00	10	0	0	0	0
_40D00	10	24.0140000	2.9765312	16.0000000	27.0000000
_80D00	10	23.5880000	4.2165937	12.0000000	27.0000000
_120D00	10	22.9960000	5.1565863	13.0000000	29.0000000
_160D00	10	18.6680000	4.3959598	13.0000000	26.0000000
_200D00	10	13.1540000	4.3651962	6.5400000	23.0000000

OBS	GOALS	PROJECT	LNAME	_NAME_	_0D00	_120D00	_160D00	_200D00	_240D00	_280D00	_320D00	_360D00	_40D00	_400D00	_440D00	_480D00	_80D00
1	1	A	Asmus	QC	15.0	12	5	2	2	2	2	2	15.0	15	.	.	.
2	1	A	Stueve	QC	5.0	2	2	2	2	.	.	.	2.0	2	.	.	.
3	1	A	gearhard	QC	0.5	1	1	10	20	.	.	.	0.5	1	.	.	.
4	1	A	johnson	QC	10.0	10	10	10	10	10	.	.	10.0	10	.	.	.
5	1	A	jones	QC	25.0	30	30	30	20	15	.	.	25.0	30	.	.	.
6	1	A	leonard	QC	25.0	25	25	25	25	25	20	20	25.0	25	.	.	.
7	1	A	norris	QC	10.0	20	20	25	15	.	.	.	15.0	20	.	.	.
8	1	A	stone	QC	23.0	10	10	7	7	5	.	.	20.0	15	.	.	.
9	1	A	west	QC	10.0	10	10	10	10	.	.	.	10.0	10	.	.	.
10	1	B	CELEBI	QC	10.0	10	10	10	10	10	10	.	10.0	10	.	.	.
11	1	B	Cooke	QC	10.0	5	2	2	2	.	.	.	10.0	5	.	.	.
12	1	B	Jacobson	QC	20.0	13	15	15	15	15	10	10	20.0	15	.	.	.
13	1	B	brady	QC	15.0	10	10	10	.	.	.	.	15.0	10	.	.	.
14	1	B	casey	QC	10.0	10	10	10	10	10	.	.	10.0	10	.	.	.
15	1	B	flick	QC	20.0	30	30	20	10	10	.	.	20.0	20	.	.	.
16	1	B	gillum	QC	15.0	10	10	10	10	.	.	.	10.0	10	.	.	.

17	1	B	hague	QC	15.0	15	10	10	10	10	.	.	15.0	15	.	.	.
18	1	B	hsing	QC	13.0	13	10	10	10	10	.	.	13.0	12	.	.	.
19	1	B	romano	QC	15.0	15	10	10	10	10	20	.	15.0	15	.	.	.
20	2	A	Dennis	QC	15.0	14	14	12	12	8	.	.	15.0	15	.	.	.
21	2	A	Lankhors	QC	20.0	20	20	20	20	20	20	20	20.0	20	.	.	.
22	2	A	Shaffer	QC	20.0	15	25	30	35	.	.	.	20.0	15	.	.	.
23	2	A	TURNER	QC	15.0	23	23	23	20	25	15	.	18.0	21	.	.	.
24	2	A	king	QC	15.0	10	15	15	18	.	.	.	17.0	17	.	.	.
25	2	A	kopper	QC	10.0	10	10	8	5	.	.	.	15.0	12	.	.	.
26	2	A	mihlon	QC	10.0	5	4	3	2	.	.	.	8.0	6	.	.	.
27	2	A	ring	QC	15.0	20	21	20	11	13	9	.	17.0	20	.	.	.
28	2	A	staier	QC	20.0	10	15	20	25	.	.	.	20.0	15	.	.	.
29	2	B	Cameron	QC	10.0	20	10	10	10	.	.	.	10.0	20	.	.	.
30	2	B	Cepek	QC	20.0	40	30	30	40	40	40	.	30.0	40	.	.	.
31	2	B	Chalfant	QC	25.0	25	15	15	15	15	.	.	25.0	25	.	.	.
32	2	B	Chaney	QC	15.0	25	25	20	20	20	.	.	20.0	20	.	.	.
33	2	B	Earley	QC	20.0	25	25	25	25	20	20	25	20.0	25	.	.	.
34	2	B	Geberth	QC	15.0	20	20	20	20	20	20	.	15.0	20	.	.	.
35	2	B	Heaton	QC	15.0	18	18	18	20	20	.	.	18.0	18	.	.	.
36	2	B	James	QC	50.0	55	40	40	40	30	30	25	50.0	50	20	25	40
37	2	B	coats	QC	15.0	25	20	20	20	20	20	.	15.0	20	.	.	.
38	2	B	waller	QC	30.0	80	30	50	40	20	20	30	30.0	60	.	.	.

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General Linear Models Procedure

Class Level Information

Class	Levels	Values
GOALS	2	1 2
PROJECT	2	A B

Number of observations in data set = 38

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General Linear Models Procedure

Repeated Measures Analysis of Variance

Repeated Measures Level Information

Dependent Variable	_0D00	_40D00	_80D00	_120D00	_160D00	_200D00
Level of PERIOD	1	2	3	4	5	6

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD Effect
H = Type III SS&CP Matrix for PERIOD E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.83872781	1.1921	5	31	0.3358
Pillai's Trace	0.16127219	1.1921	5	31	0.3358
Hotelling-Lawley Trace	0.19228192	1.1921	5	31	0.3358
Roy's Greatest Root	0.19228192	1.1921	5	31	0.3358

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD*GOALS Effect
H = Type III SS&CP Matrix for PERIOD*GOALS E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.81500205	1.4073	5	31	0.2490
Pillai's Trace	0.18499795	1.4073	5	31	0.2490
Hotelling-Lawley Trace	0.22699077	1.4073	5	31	0.2490
Roy's Greatest Root	0.22699077	1.4073	5	31	0.2490

Manova Test Criteria and Exact F Statistics for
the Hypothesis of no PERIOD*PROJECT Effect
H = Type III SS&CP Matrix for PERIOD*PROJECT E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.72838370	2.3120	5	31	0.0677
Pillai's Trace	0.27161630	2.3120	5	31	0.0677
Hotelling-Lawley Trace	0.37290277	2.3120	5	31	0.0677
Roy's Greatest Root	0.37290277	2.3120	5	31	0.0677

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General Linear Models Procedure
Repeated Measures Analysis of Variance
Tests of Hypotheses for Between Subjects Effects

Source	DF	Type III SS	Mean Square	F Value	Pr > F
GOALS	1	3793.42105263	3793.42105263	8.35	0.0066
PROJECT	1	1229.06842105	1229.06842105	2.71	0.1089
Error	35	15891.54561404	454.04416040		

General Linear Models Procedure
Repeated Measures Analysis of Variance
Univariate Tests of Hypotheses for Within Subject Effects

Source: PERIOD

DF	Type III SS	Mean Square	F Value	Pr > F	Adj Pr > F G - G	Adj Pr > F H - F
5	190.16140351	38.03228070	1.80	0.1153	0.1694	0.1634

Source: PERIOD*GOALS

DF	Type III SS	Mean Square	F Value	Pr > F	Adj Pr > F G - G	Adj Pr > F H - F
5	258.72368421	51.74473684	2.45	0.0357	0.0888	0.0810

Source: PERIOD*PROJECT

DF	Type III SS	Mean Square	F Value	Pr > F	Adj Pr > F G - G	Adj Pr > F H - F
5	334.74035088	66.94807018	3.17	0.0092	0.0438	0.0374

Source: Error(PERIOD)

DF	Type III SS	Mean Square
175	3698.59298246	21.13481704

Greenhouse-Geisser Epsilon = 0.4341
Huynh-Feldt Epsilon = 0.4903

---------------------------------- GOALS=1 PROJECT=A ----------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
_0D00	9	13.7222222	8.9061464	0.5000000	25.0000000
_40D00	9	13.6111111	8.9225059	0.5000000	25.0000000
_80D00	9	14.2222222	9.7439440	1.0000000	30.0000000
_120D00	9	13.3333333	9.8361578	1.0000000	30.0000000
_160D00	9	12.5555556	10.2238827	1.0000000	30.0000000
_200D00	9	13.4444444	10.4894127	2.0000000	30.0000000

---------------------------------- GOALS=1 PROJECT=B ----------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
_0D00	10	14.3000000	3.7133393	10.0000000	20.0000000
_40D00	10	13.8000000	3.9384148	10.0000000	20.0000000
_80D00	10	12.2000000	4.1579910	5.0000000	20.0000000
_120D00	10	13.1000000	6.6407831	5.0000000	30.0000000
_160D00	10	11.7000000	7.1499806	2.0000000	30.0000000
_200D00	10	10.7000000	4.5227818	2.0000000	20.0000000

---------------------------------- GOALS=2 PROJECT=A ----------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
_0D00	9	15.5555556	3.9086798	10.0000000	20.0000000
_40D00	9	16.6666667	3.8078866	8.0000000	20.0000000
_80D00	9	15.6666667	4.6904158	6.0000000	21.0000000
_120D00	9	14.1111111	5.9465209	5.0000000	23.0000000
_160D00	9	16.3333333	6.6708320	4.0000000	25.0000000
_200D00	9	16.7777778	8.1972218	3.0000000	30.0000000

---------------------------------- GOALS=2 PROJECT=B ----------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
_0D00	10	21.5000000	11.5590273	10.0000000	50.0000000
_40D00	10	23.3000000	11.4022415	10.0000000	50.0000000

```
_80D00   10   29.8000000   14.8832493   18.0000000   60.0000000
_120D00  10   33.3000000   19.8888579   18.0000000   80.0000000
_160D00  10   23.3000000    8.6287633   10.0000000   40.0000000
_200D00  10   24.8000000   12.1271046   10.0000000   50.0000000
------------------------------------------------------------------
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              Repeated measures on process data.            13
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  P
  R        _     _ _ _ _ _ _ _         _ _ _
 G O L     N     1 1 2 2 2 3 3  _  _  4 4 4
 O J N     A   _   2 6 0 4 8 2 6  4  8 0 4 8
O A E A    M   0 0 0 0 0 0 0 0 0  0  0 0 0 0
B L C M    E   D D D D D D D D D  D  D D D D
S S T E    _   0 0 0 0 0 0 0 0 0  0  0 0 0 0
               0 0 0 0 0 0 0 0 0  0  0 0 0 0

1 1 A Asmus    STAFF 3.5 3.5 3.5 3.0 3.0 3.0 2.9 2.9 3.5 3.5...
2 1 A Stueve   STAFF 5.0 5.0 5.0 5.0 5.0  .   .   .  4.0 5.0...
3 1 A gearhard STAFF 5.2 5.2 5.2 5.0 3.6  .   .   .  5.2 5.2...
4 1 A johnson  STAFF 4.0 6.0 6.0 6.0 6.0 6.0  .   .  4.0 6.0...
5 1 A jones    STAFF 5.0 8.0 8.0 10.0 10.0 7.0 .  .  6.0 6.0...
6 1 A leonard  STAFF 4.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 4.0 7.0...
7 1 A norris   STAFF 6.5 9.0 9.5 9.5 7.0  .   .   .  7.5 8.5...
8 1 A stone    STAFF 6.0 6.0 6.0 5.8 6.0 6.0  .   .  6.0 6.0...
9 1 A west     STAFF 5.5 6.5 5.5 4.5 4.5  .   .   .  6.5 6.5...
10 1 B CELEBI  STAFF 4.0 4.0 4.0 4.0 4.0 4.0 4.0  .  4.0 4.0...
11 1 B Cooke   STAFF 4.0 4.0 8.0 8.0 8.0  .   .   .  4.0 4.0...
12 1 B Jacobson STAFF 4.0 4.2 4.2 6.0 6.0 6.0 6.0 6.0 4.0 4.0...
13 1 B brady   STAFF 3.5 7.0 7.0 7.0  .   .   .   .  10.0 10.0...
14 1 B casey   STAFF 5.0 4.5 4.5 5.5 5.5 5.5  .   .  5.0 5.0...
15 1 B flick   STAFF 5.0 10.0 10.0 10.0 10.0 10.0 . . 5.0 8.0...
16 1 B gillum  STAFF 6.0 5.3 5.5 8.0 6.0  .   .   .  6.0 5.5...
17 1 B hague   STAFF 7.0 7.0 7.0 9.0 9.0 9.0  .   .  7.0 7.0...
18 1 B hsing   STAFF 3.5 6.0 6.0 6.0 6.0 6.0  .   .  5.0 5.0...
19 1 B romano  STAFF 4.0 4.0 6.0 6.0 6.0 6.0 6.0  .  4.0 4.0...
20 2 A Dennis  STAFF 5.0 8.0 8.0 8.0 8.0 8.0  .   .  5.0 7.0...
21 2 A Lankhors STAFF 10.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 10.0 6.0...
22 2 A Shaffer STAFF 5.0 9.0 15.0 15.0 7.0 .   .   .  5.0 9.0...
23 2 A TURNER  STAFF 4.0 8.0 8.0 8.0 8.0 8.0 8.0  .  6.0 8.0...
24 2 A king    STAFF 5.0 8.0 8.0 8.0 7.0  .   .   .  6.5 7.5...
25 2 A kopper  STAFF 4.0 6.0 6.5 6.5 6.5  .   .   .  5.0 5.0...
26 2 A mihlon  STAFF 4.0 6.0 6.0 8.0 7.0  .   .   .  4.0 6.0...
27 2 A ring    STAFF 5.0 7.0 7.0 8.0 10.0 10.0 10.0 . 5.0 7.0...
28 2 A staier  STAFF 5.5 12.0 11.0 9.5 6.0 .   .   .  9.0 10.0...
29 2 B Cameron STAFF 5.0 6.0 10.0 10.0 10.0 .  .   .  6.0 6.0...
30 2 B Cepek   STAFF 6.0 7.0 8.0 8.0 9.0 9.0 9.0  .  7.0 7.0...
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31 2 B Chalfant STAFF  8.0  7.0  7.0  6.0  6.0  6.0   .    .   8.0  8.0 . . .
32 2 B Chaney   STAFF  5.0  7.0  8.0 10.0 15.0 15.0   .    .   7.0  7.0 . . .
33 2 B Earley   STAFF  3.5  5.0  8.0  8.0  8.0  8.0  8.0  8.0  3.5  5.0 . . .
34 2 B Geberth  STAFF  4.0  5.0  5.0  5.0  5.0  5.0  6.0   .   4.0  5.0 . . .
35 2 B Heaton   STAFF  5.0  8.0  8.0 10.0 10.0 10.0   .    .   6.0  8.0 . . .
36 2 B James    STAFF  4.0  5.0  5.0  5.0  5.0  5.0  6.0  6.0  5.0  5.0 6 6 6
37 2 B coats    STAFF  5.0  6.0  6.0  8.0  8.0  8.0  8.0   .   5.0  5.0 . . .
38 2 B waller   STAFF  5.0  5.0  5.0  5.0  7.0 10.0 20.0 20.0  5.0  5.0 . . .
```


General Linear Models Procedure
Class Level Information

Class	Levels	Values
GOALS	2	1 2
PROJECT	2	A B

Number of observations in data set = 38

General Linear Models Procedure
Repeated Measures Analysis of Variance
Repeated Measures Level Information

Dependent Variable	_0D00	_40D00	_80D00	_120D00	_160D00	_200D00
Level of PERIOD	1	2	3	4	5	6

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD Effect
H = Type III SS&CP Matrix for PERIOD E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.51513667	5.8356	5	31	0.0007

Pillai's Trace	0.48486333	5.8356	5	31	0.0007
Hotelling-Lawley Trace	0.94123242	5.8356	5	31	0.0007
Roy's Greatest Root	0.94123242	5.8356	5	31	0.0007

Manova Test Criteria and Exact F Statistics for the Hypothesis of no PERIOD*GOALS Effect

H = Type III SS&CP Matrix for PERIOD*GOALS E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.95522269	0.2906	5	31	0.9145
Pillai's Trace	0.04477731	0.2906	5	31	0.9145
Hotelling-Lawley Trace	0.04687631	0.2906	5	31	0.9145
Roy's Greatest Root	0.04687631	0.2906	5	31	0.9145

Manova Test Criteria and Exact F Statistics for
the Hypothesis of no PERIOD*PROJECT Effect

H = Type III SS&CP Matrix for PERIOD*PROJECT E = Error SS&CP Matrix

S=1 M=1.5 N=14.5

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.80610911	1.4913	5	31	0.2211
Pillai's Trace	0.19389089	1.4913	5	31	0.2211
Hotelling-Lawley Trace	0.24052686	1.4913	5	31	0.2211
Roy's Greatest Root	0.24052686	1.4913	5	31	0.2211

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General Linear Models Procedure
Repeated Measures Analysis of Variance
Tests of Hypotheses for Between Subjects Effects

Source	DF	Type III SS	Mean Square	F Value	Pr > F
GOALS	1	45.63157895	45.63157895	4.05	0.0519
PROJECT	1	12.88507018	12.88507018	1.14	0.2921
Error	35	394.13475439	11.26099298		

Repeated measures on process data. 17

General Linear Models Procedure
Repeated Measures Analysis of Variance
Univariate Tests of Hypotheses for Within Subject Effects

Source: PERIOD

DF	Type III SS	Mean Square	F Value	Pr > F	Adj Pr > F G - G	Adj Pr > F H - F
5	131.39669591	26.27933918	14.42	0.0001	0.0001	0.0001

Source: PERIOD*GOALS

DF	Type III SS	Mean Square	F Value	Pr > F	Adj Pr > F G - G	Adj Pr > F H - F
5	6.85157895	1.37031579	0.75	0.5856	0.4724	0.4858

Source: PERIOD*PROJECT

DF	Type III SS	Mean Square	F Value	Pr > F	Adj Pr > F G - G	Adj Pr > F H - F
5	6.97774854	1.39554971	0.77	0.5755	0.4660	0.4790

Source: Error(PERIOD)

DF	Type III SS	Mean Square
175	318.86453216	1.82208304

Greenhouse-Geisser Epsilon = 0.3907
Huynh-Feldt Epsilon = 0.4372

---------------------------------- GOALS=1 PROJECT=A ----------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
_0D00	9	4.9666667	0.9861541	3.5000000	6.5000000
_40D00	9	5.1888889	1.3905435	3.5000000	7.5000000
_80D00	9	5.9666667	1.3865425	3.5000000	8.5000000
_120D00	9	6.2444444	1.6432522	3.5000000	9.0000000
_160D00	9	6.1888889	1.7702009	3.5000000	9.5000000
_200D00	9	6.2000000	2.2961925	3.0000000	10.0000000

---------------------------------- GOALS=1 PROJECT=B ----------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
_0D00	10	4.6000000	1.1498792	3.5000000	7.0000000
_40D00	10	5.4000000	1.8973666	4.0000000	10.0000000
_80D00	10	5.6500000	2.0554805	4.0000000	10.0000000
_120D00	10	5.6000000	1.9544820	4.0000000	10.0000000
_160D00	10	6.2200000	1.8635689	4.0000000	10.0000000
_200D00	10	6.9500000	1.8020051	4.0000000	10.0000000

---------------------------------- GOALS=2 PROJECT=A ----------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
_0D00	9	5.2777778	1.8559215	4.0000000	10.0000000
_40D00	9	6.1666667	2.0310096	4.0000000	10.0000000
_80D00	9	7.2777778	1.5634719	5.0000000	10.0000000
_120D00	9	7.5555556	2.2422707	4.0000000	12.0000000
_160D00	9	8.1666667	3.1819805	4.0000000	15.0000000
_200D00	9	8.3333333	2.9261750	4.0000000	15.0000000

---------------------------------- GOALS=2 PROJECT=B ----------------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
_0D00	10	5.0500000	1.2572015	3.5000000	8.0000000
_40D00	10	5.6500000	1.4151953	3.5000000	8.0000000
_80D00	10	6.1000000	1.2866839	5.0000000	8.0000000
_120D00	10	6.1000000	1.1005049	5.0000000	8.0000000
_160D00	10	7.0000000	1.6996732	5.0000000	10.0000000
_200D00	10	7.5000000	2.1213203	5.0000000	10.0000000

APPENDIX Q: PERFORMANCE DATA

OBS	LNAME	PROJECT	GOALS	ORDER	FNCOST	FNSKED	FNERR
1	Asmus	A	1	1	1082.44	360.0	1266.44
2	johnson	A	1	1	1496.63	312.0	1885.45
3	jones	A	1	1	1968.05	307.5	622.44
4	leonard	A	1	1	2040.21	365.5	559.06
5	norris	A	1	1	1756.22	251.0	1481.82
6	gearhard	A	1	2	1199.47	270.5	9781.81
7	stone	A	1	2	1630.60	310.0	738.44
8	Stueve	A	1	2	1142.96	269.0	7302.89
9	west	A	1	2	1348.78	271.0	2126.43
10	Dennis	A	2	1	1810.19	299.0	1097.82
11	kopper	A	2	1	1280.43	268.0	1932.55
12	Lankhors	A	2	1	1639.19	374.0	578.61
13	Shaffer	A	2	1	1972.70	258.5	771.77
14	TURNER	A	2	1	2061.62	327.0	873.75
15	king	A	2	2	1521.59	251.5	1184.90
16	mihlon	A	2	2	1280.33	264.0	2573.47
17	ring	A	2	2	2068.38	329.0	910.61
18	staier	A	2	2	1996.02	257.0	786.59
19	brady	B	1	1	1387.75	240.0	1334.88
20	CELEBI	B	1	1	1274.16	352.0	1822.62
21	flick	B	1	1	2083.64	295.0	689.42
22	hsing	B	1	1	1349.10	289.5	1588.36
23	romano	B	1	1	1398.31	321.5	1251.58
24	casey	B	1	2	1381.59	312.0	1800.63
25	Cooke	B	1	2	1167.53	259.0	2676.52
26	gillum	B	1	2	1328.09	259.0	1500.12
27	hague	B	1	2	1473.53	244.0	1290.76
28	Jacobson	B	1	2	1668.26	379.5	677.79
29	Cepek	B	2	1	2227.05	336.0	604.23
30	coats	B	2	1	1878.66	338.0	933.29
31	Heaton	B	2	1	2165.74	315.5	909.67
32	James	B	2	1	2389.62	502.0	501.79
33	waller	B	2	1	2311.00	378.0	607.66
34	Cameron	B	2	2	1700.44	274.5	1824.09
35	Chalfant	B	2	2	1848.91	307.5	570.79
36	Chaney	B	2	2	1936.47	285.5	955.76
37	Earley	B	2	2	2080.11	374.5	634.56
38	Geberth	B	2	2	1520.04	354.0	932.55

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---------------------------- PROJECT=A GOALS=1 --------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
FNCOST	9	1518.37	354.5411686	1082.44	2040.21
FNSKED	9	301.8333333	40.6717039	251.0000000	365.5000000
FNERR	9	2862.75	3323.77	559.0600000	9781.81
FNERG	9	576.5511111	48.1981378	535.7200000	678.5300000
FNERD	9	271.6488889	167.1901172	52.8800000	536.4400000
FNERES	9	304.9011111	140.5700447	136.9500000	516.3700000
FNPRDT	9	46.1355556	26.0814619	9.2900000	79.0600000
FNQAMD	9	219.7011111	183.5586347	26.5200000	506.8600000
FNTRMD	9	94.2944444	34.9914965	39.2100000	141.9100000
FNRWMD	9	197.8455556	118.9816874	36.9800000	359.2900000

---------------------------- PROJECT=A GOALS=2 --------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
FNCOST	9	1736.72	319.4066121	1280.33	2068.38
FNSKED	9	292.0000000	42.8872067	251.5000000	374.0000000
FNERR	9	1190.01	648.4037547	578.6100000	2573.47
FNERG	9	604.9800000	52.1847159	550.1000000	690.5500000
FNERD	9	368.2533333	120.7299899	115.9300000	532.1700000
FNERES	9	236.7255556	111.7545648	151.0600000	455.6100000
FNPRDT	9	60.7177778	18.7304203	20.2800000	77.0600000
FNQAMD	9	284.8488889	135.3733590	62.9400000	468.1000000
FNTRMD	9	125.6377778	34.8176284	77.7900000	179.9500000
FNRWMD	9	271.3388889	87.3096888	87.0600000	339.3700000

---------------------------- PROJECT=B GOALS=1 --------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
FNCOST	10	1451.20	257.4781858	1167.53	2083.64
FNSKED	10	295.1500000	46.7006127	240.0000000	379.5000000
FNERR	10	1463.27	581.0722069	677.7900000	2676.52
FNERG	10	633.2490000	62.8253792	535.0200000	747.9700000
FNERD	10	325.0920000	117.2672678	96.6400000	566.6200000
FNERES	10	308.1570000	102.0192853	181.3500000	551.1500000
FNPRDT	10	51.0770000	15.8040255	14.9200000	75.7500000

FNQAMD	10	179.4270000	100.7888221	51.9100000	431.2800000
FNTRMD	10	96.1850000	27.0112126	58.4800000	161.4300000
FNRWMD	10	218.9240000	89.2661783	71.2600000	418.7300000

---------------------------- PROJECT=B GOALS=2 --------------------------

Variable	N	Mean	Std Dev	Minimum	Maximum
FNCOST	10	2005.80	277.9513111	1520.04	2389.62
FNSKED	10	346.5500000	64.6204517	274.5000000	502.0000000
FNERR	10	847.4390000	386.1544804	501.7900000	1824.09
FNERG	10	594.4380000	62.0690900	529.1400000	717.9000000
FNERD	10	436.6400000	72.4674781	333.3700000	581.1000000
FNERES	10	157.7990000	36.4246688	124.2400000	251.2300000
FNPRDT	10	73.2200000	6.6202853	57.0300000	80.9400000
FNQAMD	10	502.2280000	237.0315975	213.9400000	875.8100000
FNTRMD	10	136.3760000	30.4277831	81.7400000	189.1200000
FNRWMD	10	318.7870000	31.6099137	245.5600000	357.8000000

General Linear Models Procedure
Class Level Information

Class	Levels	Values
PROJECT	2	A B
GOALS	2	1 2
ORDER	2	1 2

Number of observations in data set = 38

General Linear Models Procedure

Dependent Variable: FNCOST
Sum of Mean

Source	DF	Squares	Square	F Value	Pr > F
Model	4	2277775.07	569443.77	7.00	0.0003
Error	33	2684989.92	81363.33		
Corrected Total	37	4962765.00			

R-Square	C.V.	Root MSE	FNCOST Mean
0.458973	16.97186	285.243	1680.68

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PROJECT	1	96554.96	96554.96	1.19	0.2839
GOALS	1	1484675.65	1484675.65	18.25	0.0002
ORDER	1	428737.80	428737.80	5.27	0.0282
PROJECT*GOALS	1	267806.67	267806.67	3.29	0.0787

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PROJECT	1	120152.18	120152.18	1.48	0.2329
GOALS	1	1415022.07	1415022.07	17.39	0.0002
ORDER	1	428737.80	428737.80	5.27	0.0282
PROJECT*GOALS	1	267806.67	267806.67	3.29	0.0787

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General Linear Models Procedure

Dependent Variable: FNSKED

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	29400.5405	7350.1351	3.24	0.0239
Error	33	74829.7029	2267.5668		
Corrected Total	37	104230.2434			

R-Square	C.V.	Root MSE	FNSKED Mean
0.282073	15.38512	47.6190	309.513

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PROJECT	1	5426.5684	5426.5684	2.39	0.1314
GOALS	1	4764.4803	4764.4803	2.10	0.1566
ORDER	1	10329.0471	10329.0471	4.56	0.0403
PROJECT*GOALS	1	8880.4447	8880.4447	3.92	0.0562

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PROJECT	1	6272.2748	6272.2748	2.77	0.1058
GOALS	1	4092.1289	4092.1289	1.80	0.1883
ORDER	1	10329.0471	10329.0471	4.56	0.0403
PROJECT*GOALS	1	8880.4447	8880.4447	3.92	0.0562

General Linear Models Procedure

Dependent Variable: FNERR

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	33357863.8	8339466.0	3.26	0.0233
Error	33	84440905.2	2558815.3		
Corrected Total	37	117798769.0			

R-Square	C.V.	Root MSE	FNERR Mean
0.283177	102.0208	1599.63	1567.95

Source	DF	Type I SS	Mean Square	F Value	Pr > F
PROJECT	1	7187571.8	7187571.8	2.81	0.1032
GOALS	1	11841878.1	11841878.1	4.63	0.0389
ORDER	1	11682715.6	11682715.6	4.57	0.0401
PROJECT*GOALS	1	2645698.3	2645698.3	1.03	0.3166

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PROJECT	1	8218043.7	8218043.7	3.21	0.0823
GOALS	1	12404779.3	12404779.3	4.85	0.0348
ORDER	1	11682715.6	11682715.6	4.57	0.0401
PROJECT*GOALS	1	2645698.3	2645698.3	1.03	0.3166

APPENDIX R. SAMPLE CAPTURE.DAT

```
NAME SMC# A 2 1 40 R1   70
NAME SMC# A 2 1 40 R2   29
NAME SMC# A 2 1 40 R3   54
NAME SMC# A 2 1 40 G4   33
NAME SMC# A 2 1 40 G8   13
NAME SMC# A 2 1 40 R1  280
NAME SMC# A 2 1 40 G5   12
NAME SMC# A 2 1 40 R1  317
NAME SMC# A 2 1 80 R1   51
NAME SMC# A 2 1 80 R2   23
NAME SMC# A 2 1 80 R3   55
NAME SMC# A 2 1 80 G4   22
NAME SMC# A 2 1 80 G5   10
NAME SMC# A 2 1 80 G8   13
NAME SMC# A 2 1 80 R1  332
NAME SMC# A 2 1 80 R1  320
NAME SMC# A 2 1 120 R1   36
NAME SMC# A 2 1 120 R2   29
NAME SMC# A 2 1 120 R3   60
NAME SMC# A 2 1 120 G8   15
NAME SMC# A 2 1 120 G5    5
NAME SMC# A 2 1 120 G4   31
NAME SMC# A 2 1 120 R1  218
NAME SMC# A 2 1 160 R1   15
NAME SMC# A 2 1 160 G6   10
NAME SMC# A 2 1 160 R3    4
NAME SMC# A 2 1 160 R2   20
NAME SMC# A 2 1 160 R3   25
NAME SMC# A 2 1 160 G6   11
NAME SMC# A 2 1 160 R1   93
NAME SMC# A 2 1 200 R1   24
NAME SMC# A 2 1 200 R2   25
NAME SMC# A 2 1 200 R3   20
NAME SMC# A 2 1 200 G6   45
NAME SMC# A 2 1 200 G5    6
NAME SMC# A 2 1 200 R1  124
NAME SMC# A 2 1 240 R1   18
NAME SMC# A 2 1 240 R2   20
NAME SMC# A 2 1 240 R3   43
NAME SMC# A 2 1 240 G4   16
NAME SMC# A 2 1 240 G6   90
NAME SMC# A 2 1 240 R1  203
NAME SMC# A 2 1 280 R1   30
NAME SMC# A 2 1 280 R2   31
NAME SMC# A 2 1 280 R3   14
NAME SMC# A 2 1 280 G6   14
NAME SMC# A 2 1 280 G4   13
NAME SMC# A 2 1 280 R1  278
NAME SMC# A 2 1 320 R1   26
NAME SMC# A 2 1 320 G5    7
NAME SMC# A 2 1 320 R3    8
NAME SMC# A 2 1 320 R1   13
```

APPENDIX S. SAS PROGRAM FILES

PERFORMANCE.SAS:

```
title "Performance data " ;
options linesize=75;
options pagesize=200;
data one;

infile "/h/joshua_u1/tmroylan/thesis/Timdata/performance.dat";
input lname $ smc $ project $ goals $ order $  fncost fnsked fnerr
     fnerg fnerd fneres fnprdt fnqamd fntrmd fnrwmd;


/*
if (project='B') then delete;
if (project='A') then delete;
if (project='A') then initcost=944;
if (project='A') then initsked=272;
if (project='B') then initcost=1960;
if (project='B') then initsked=272;
costdev = abs(fncost-initcost);
pcostdev = abs(fncost-initcost)/fncost;
skeddev = abs(fnsked-initsked);
pskeddev = abs(fnsked-initsked)/fnsked;
*/



if (project='C') then delete;



proc sort;
  by project goals order  ;

proc print; var lname project goals order fncost fnsked fnerr;


proc means;  by project goals ;
```

```
proc glm;
 class  project goals order   ;
 model fncost fnsked fnerr /* fnerg fnerd fneres fnprdt
      fnqamd fntrmd fnrwmd fncost  */= project goals order project*goals  ;

 run;
```

PROCESS.SAS

```
libname dataname "/h/joshua_u1/tmroylan/thesis/Timdata";
options pagesize=200;
title "Repeated measures on process data. " ;
data dataname.dat (keep= lname  smc   project  goals  order  time
                         qc);
infile "/h/joshua_u1/tmroylan/thesis/Timdata/process.dat";
input lname $ smc $ project $ goals $ order $ time $ var1-var27  prod
staff qc cost duration ;


 if (project='C') then delete;


proc sort data=dataname.dat out=dataname.sort;
  by  goals project lname time ;

/*
proc means;  by project goals lname time ;
  var staff qc cost duration;
*/

proc transpose data=dataname.sort out=dataname.trans
/* (rename=(_0.00=y1 _40.00=y2 _80.00=y3 _120.00=y4 _160.00=y5
_200.00=y6
         _240.00=y7))*/;
   by goals project lname;
    id time;

proc print;

 proc glm data=dataname.trans;
   class goals project ;
```

```
  model  _0D00 _40D00 _80D00 _120D00 _160D00 _200D00
      = goals project/nouni;
  repeated period /*polynomial /short summary*/;
 proc means;
  var  _0D00 _40D00 _80D00 _120D00 _160D00 _200D00;
    by goals project;
run;
```

CAPTURE.SAS

```
libname dataname "/h/joshua_u1/tmroylan/thesis/Timdata";
options pagesize=200;
title "Repeated measures on capture data. " ;
data dataname.dat (keep= lname smc  project goals order time
                  g4time);
infile "/h/joshua_u1/tmroylan/thesis/Timdata/capture.dat";
input lname $ smc $ project $ goals $ order $ time $ r1freq r1time r2freq r2time
    r3freq r3time r4freq r4time g1freq g1time g2freq g2time g3freq g3time
    g4freq g4time;


 if (project='C') then delete;


proc sort data=dataname.dat out=dataname.sort;
  by  goals project lname time ;


proc transpose data=dataname.sort out=dataname.trans
/* (rename=(_0.00=y1 _40.00=y2 _80.00=y3 _120.00=y4 _160.00=y5
_200.00=y6
        _240.00=y7))*/;
   by goals project lname;
   id time;

proc print;

 proc glm data=dataname.trans;
   class goals project ;
   model  _0 _40  _80  _120  _160  _200
      = goals project/nouni;
```

```
 repeated period /*polynomial /short summary*/;
proc means;
 var  _0 _40  _80  _120  _160  _200;
   by goals project;
run;
```

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